Railway Mechanical Engineer

Volume 97 June, 1923 No. 6

Reporting the Mechanical Meeting

In previous years when the June Mechanical Conventions have been held at Atlantic City, the readers of the *Railway Mechanical Engineer* have had the benefit of getting a prompt and complete report of the meeting as the Railway Age, which is also published by the Simmons-Boardman Publishing Company, has brought out Daily issues which have been sent to subscribers to the *Railway Mechanical Engineer*. This year the Mechanical Convention will not be held, but in its place there will be a brief three-day meeting in Chicago. While there will be no Daily issues of the Railway Age, the *Railway Mechanical Engineer* will give all its readers a full and authentic account of the entire proceedings with complete reports of the addresses, papers, committee reports and discussions at the session. The complete account of the mechanical meeting will appear in the July number of the *Railway Mechanical Engineer*. In addition, there will be the usual variety of articles on locomotives, cars and shops, such as are published in each of the regular monthly issues.

Two Apprentice Competitions

The war, post-war conditions and the shopmen's strike all interfered greatly with the development of modern apprenticeship methods on the railroads. This is unfortunate because even on some of the most progressive roads much still remained to be done in pre-war days in perfecting the recruiting and training systems in the mechanical department. Fortunately many roads now seem to be awakening to the necessity of taking forward steps in these respects. It is significant, for instance, that hardly a week passes by but what one road which is noted for its apprenticeship training methods receives requests for information about these methods and practices and the results which are being obtained through their use. The Mechanical Division of the American Railway Association made a place on its June program for the consideration of shop apprenticeship.

A number of years ago we invited the apprentices themselves to tell us what they thought about apprenticeship—how it helped them and how in their opinion the methods could be changed or modified, or improved better to meet their needs. It is well to check up occasionally and to look at the whole question from the standpoint of the young men who are training to fit themselves for efficient service and larger responsibilities. The results from the above-mentioned competition were most refreshing and constructive.

We wish to announce a similar competition, with first and second prizes of $35 and $25, for the best articles received from regular apprentices now in service, along the lines above suggested. The prizes will be awarded on the basis of the practical value of the observations or suggestions which may be offered.

There are not a few college men who are now serving as apprentices (regular or special) on railroads in various parts of the country. We want to hear from these men, or from undergraduates who spent last summer or will spend the coming summer on the railroads in the mechanical department. A second competition is therefore announced, with first and second prizes of $35 and $25, for the best papers received from college graduates or college students, commenting upon the opportunities which are being offered to them by the railroads, and how the railroads can make the best use of the services of college men. No limit is placed upon the length of the contributions, but generally speaking, they should contain not more than one thousand words. Only contributions will be considered which are received in our office in New York on or before September 1, 1923.

In order to prevent any confusion please make clear in sending in your contribution which competition it is intended for.

Equipment for Engine Terminals

An examination of the machine tools and other equipment provided for many an engine terminal shop—not only at the small outlying points but also at important places where a large number of locomotives are turned each day—would lead one to form the impression that any old machine after having seen a long period of usefulness in some main shop and having been superseded by a modern type machine is considered amply good enough for the miscellaneous jobs that have to be done at a terminal shop. There may be a measure of correctness in this attitude as far as it pertains to the terminal where few locomotives are handled and where excellent shop facilities are available at the other end of the runs. There is, however, one important fact that should not be lost sight of. When the occasion arises in which a repair job involving machine work must be done at a locomotive terminal, the rapidity with which it is performed is often of the greatest importance. Locomotive terminals are built and operated solely in order that locomotives may be cared for, turned and delivered back to the transportation department in good order and as promptly as traffic conditions demand. Delays caused by engine failures on the road or on account of a terminal not having a suitable locomotive available whenever called for may seriously disarrange the movement of trains and be extremely expensive.

The fact that a machine would frequently be idle at a terminal shop while the same machine would be used a large part of the time were it located at a main repair shop does not prove that it would not earn fully as much for the railroad when located at the former point as at the latter. A correct valuation of service rendered involves consideration of interest on investment, attendant labor costs and the possible expenses resulting from delays caused by the length of time taken to do the work. Due to the importance of the time element at terminal shops, there is a tremendous incentive for the equipment of such points with modern tools that can be pushed to the limit when occasion arises. Such tools

have the further advantage of enabling a man to do a far more accurate job than is possible with an old, badly worn machine and accuracy is of great importance in keeping locomotives in service without frequent attention from the shop forces. It is not the intention to belittle the need of better equipment for the back shop—for such need is all too apparent—but to point out the large part played by the terminal shop in the general performance of a railroad's activities and to direct attention to the importance of its claims for an adequate share of investments in betterments.

How Is Your Shop Laid Out?

The time required to do a certain job, and consequently the cost of the operation, is affected by a number of factors. When the subject is given consideration, attention is commonly directed first to the machinery provided and the skill or efficiency of the workmen. A large factor, however, although one frequently not given the full attention that it deserves, is the general arrangement of the shop and the layout of the machinery so that the work most frequently performed can be done with as few movements as possible and these in the most direct route to the erecting shop, enginehouse or whatever point the material is destined for. In manufacturing plants where detailed costs are known and form the basis of managerial control, the great importance of shop layout is well recognized and rearrangements of equipment are made when it is seen that by so doing the handling of work will be expedited. Railroad mechanical officers are somewhat prone to think that this may be essential in a strictly manufacturing plant devoted to turning out a limited line of products in large quantities, but does not apply to any great extent to railroad shops. In this connection it is interesting to note the attention given to the subject of layout in planning the shop for building steel freight cars of which a description is given in this issue. Not only were machines so placed that material would move progressively from the storage yard at the end of the building through to the erecting shop, but care was taken to prevent interference between different jobs and in order that there might be a minimum of delay due to waiting for crane service, ample provision was made for auxiliary jib cranes and other handling devices. The principles followed in the arrangement of this shop are general in their application and should serve to direct attention to a problem that is worthy of considerable thought. Take your own shop for example, would it not be possible to reduce trucking, save delays in handling, prevent interference between different jobs, decrease costs and add to capacity by some relatively inexpensive changes in layout?

Advantages of Short Repair Schedules

The possibility, and indeed necessity, of shorter repair schedules is indicated by the fact that many present railroad shops require from 12 to 15 or more days to repair a locomotive, whereas it has been demonstrated that heavy general repairs, including new flues applied, tires turned and general repairs to machinery, can be made in eight working days. True, the physical limitations of existing plants usually present more or less of a blank wall, but other factors than shop size and equipment enter into the problem and sometimes do not rceive proper attention.

The advantages of a short repair schedule are apparent. In the first place, decreasing the time locomotives are in the backshop for repairs hastens their return to service in which they can earn revenue. In addition, fewer locomotives will be undergoing repairs at the same time, so that a given traffic can be handled with a smaller total number of locomotives. This means a smaller investment in motive power and also lower maintenance-of-equipment costs. A decrease in the number of locomotives in the shop at the same time will decrease the required shop space, reducing shop overhead expense. The number of repair parts going through the shop at one time will also be reduced, decreasing congestion and confusion in the shop and having a definite tendency to speed up the work and reduce unit costs.

The length of repair periods is dependent largely on the relative proportionate size and equipment of the various shop departments, and it is to be feared that in too many cases insufficient attention was given this matter when many of the present repair shops were designed. Obviously if the machine shop is weak, either through lack of space or machinery, locomotives will be delayed in the shop longer than necessary while waiting for machine parts. The machine shop is usually the limiting factor, although frequently heavy boiler jobs and new cylinder applications determine the minimum number of working days in which a locomotive can be repaired.

The space limitations in present shops are largely fixed by the original construction although in some cases additions can be made to existing plants at relatively small expenditure. By providing additional machine equipment, increasing the shop force, or working two shifts, however, the shop managements are in a position to strengthen weak departments and make sure that locomotives are being repaired in the minimum time consistent with good workmanship. The subject of proper department proportions in railroad shops is one of great importance and deserves close study by those interested.

Reducing Idle Time of Locomotives

On account of the heavy demand for motive power at this time, a great deal of attention is being given to methods for increasing the monthly mileage obtained from locomotives. In addition to lengthening runs, it is probable that many roads would find the practice of turning locomotives without putting them into the house to be helpful in attaining this object, particularly where outside inspection pits are available and where the roundhouse is congested.

It is not unusual to find terminals working at the maximum capacity when the time each locomotive can spend in the house is too short to permit thorough repairs to be made. The engines are placed on the roundhouse pit, inspected, cleaned and cooled down in preparation for repairs. Due to the necessity for keeping down the time spent in the house, the only work done is that which is absolutely necessary. Minor defects are passed by and the locomotives are allowed to run, wasting fuel and water, using too much time on the road and wearing out rapidly.

Back shop repairs to locomotives are always costly and roundhouse work should be done with the object of keeping the locomotive out of the shop as long as possible. Locomotives can be kept in efficient condition up to the limit of wear if repairs are not slighted. Most roads have rules for maintenance which, if observed, would insure efficient motive power, but too often in a mistaken attempt to reduce costs the workmen are not required to live up to the instructions.

The time which locomotives spend in the roundhouses is not only unproductive, it is a source of expense. Nevertheless it is not uncommon to find that on a large proportion of engines more money is spent in turning them than in repairing them while they are in the roundhouse. Inspection pits combined with work pits are very helpful in getting locomotives requiring only minor repairs back into service quickly and allowing the roundhouse forces to keep engines in need of heavier repairs on the pits long enough to do the work in a thorough manner. In view of the advantage to be gained by this practice, it is hard to understand why railroads do not adopt it more extensively.

What Our Readers Think

Excessive Weight of Reciprocating Parts

NEW YORK.

TO THE EDITOR:

In G. M. Basford's excellent paper entitled "As to the Locomotive—What Next?" presented before the Pacific Railway Club, March 8, 1923,* he says: "What do you think of reciprocating parts of a big freight engine that weigh 2,600 lb.? I call it brutality, not engineering." Mr. Basford, as usual, is right, and furthermore there is absolutely no excuse for the existence of such brutal practice.

As an example of what can be accomplished by skillful designing, even without resorting to the use of alloy steel, we may refer to the Pennsylvania Railroad class E6s, 4-4-2 type locomotive (built in 1914 and since slightly modified), weighing 243,600 lb. in working order, and developing 31,275 lb. tractive force, in which, although the maximum piston load is 89,000 lb., the weight of the reciprocating parts is but 1/240 of the total weight of the engine; 60.3 per cent of the reciprocating weight is balanced; the unbalanced reciprocating weight is but 1/604.5 of the total weight of the locomotive, instead of 1/400 of this weight as recommended by the American Railway Master Mechanics' Association in 1896; and at 70 m.p.h. the "dynamic augment" for any wheel is but 28.7 per cent of the static rail load.

Can any other heavy Atlantic type locomotive in this country measure up to these ratios? If not, is it because the Pennsylvania appreciates more fully than any other American railroad the vital importance of light reciprocating parts and correct counter-balancing? How much longer are a large number of our railroads willing to continue to plead guilty to the indictment of substituting brutality for engineering in the design of the reciprocating parts of their locomotives?

EDWARD L. COSTER.

Co-operation, Not Criticism Needed in Development Work

CHICAGO.

TO THE EDITOR:

As one having experience on both sides, I wish to comment on Entropy's essay on co-ordination in your May issue, and quote one paragraph that seems very unfair.

"Again, not a few railroad officers seem to be incapable of placing proper values on any new device brought before them and are not always willing to accept the advice of those most capable of giving a disinterested opinion. Hence we find they are very much impressed by so-called tests and comparisons always, of course, in favor of the device. Such tests are generally found to have been carried out under quite different conditions and so are valueless from an engineering point of view although no doubt useful as 'selling talk.'"

I would like to ask how many of the devices on railroad equipment are of railroad origin? True, practically all of them may be credited to railroad development as the test of service is the only real one in most cases; but, to bring them to trial and use, as a rule the manufacturer must expend time and means for several years before his device, possibly only usable on railroads, receives recognition and financial return.

All this is a hazard of business, of course, but why should the tests and "selling talk" of men just as earnest and deserving in prosecuting a life work as any railroad man be so severely discredited?

It is well known that from a business point of view many railroad practices are difficult to understand. They often buy and repair at peak prices of labor and materials and Entropy is not far wrong in describing some practices in equipment purchasing.

It is a fact, however, that the devices so originated and developed have built up railroad equipment in capacity, economy and efficiency through the co-operation of inventors, manufacturers and builders, with the railroads, and it is not difficult to imagine the status were such co-operation lacking.

C. A. SELEY.

*Railway Mechanical Engineer, April, 1923, pp. 212-216.

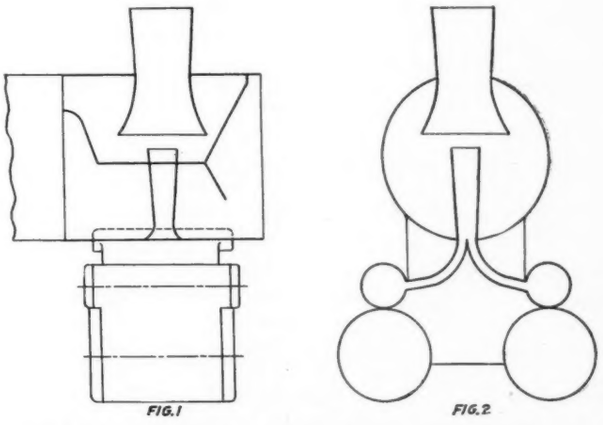
Expanding Exhaust Nozzle for Locomotives

DALLAS, TEX.

TO THE EDITOR:

In studying the problem of induced draft for locomotives, the merits of the exhaust nozzle shown in the illustration should receive consideration. As will be seen from Fig. 1, the nozzle follows modern turbine practice and is so constructed that the steam expands in the nozzle and the pressure is converted to velocity. The velocity through this type of nozzle is double that due to pressure alone when exhausting from a straight nozzle. Since the vacuum obtained in the front end is dependent on the velocity of the exhaust jet, it should be possible to obtain the desired draft with a considerable reduction of back pressure on the pistons. If the exhaust passages are joined at an acute angle as shown in Fig. 2, the exhaust from one cylinder will have an ejector action on the exhaust passage leading to the opposite cylinder, tending to still further reduce the back pressure in this cylinder.

If the back pressure was only reduced 5 lb. per sq. in., this would mean a considerable gain in power. As an example, a locomotive with 27-in. cylinders at 1,000 ft. per min. piston speed would show a gain of 173.4 horsepower. The exhausts are much softer with this type of nozzle and there is little danger of tearing holes in the fire when starting heavy trains; cinder losses would also be greatly reduced.



Proposed Expanding Exhaust Nozzle for Locomotives

This type of nozzle and the exhaust ejector principle have been applied to some recent unaflow locomotives in Germany and the results have been entirely satisfactory. It is claimed that a vacuum of 7 in. was obtained in the exhaust passages at certain parts of the stroke and a steam economy of 12 per cent was obtained at 45 per cent cut-off, decreasing the zero at 14 per cent cut-off. I believe that better re-

sults can be obtained with a counter-flow locomotive owing to the exhausts overlapping to a greater extent than is possible in the German engines.

Of course, to obtain the best results the exhaust passages and nozzle must be designed to give as unrestricted flow as possible to the exhaust steam. However, I believe that a properly designed nozzle of this type applied to existing locomotives will show considerable improvement over the present type.

P. D. ANDERSON.

New Books

JIGS AND FIXTURES. *By Albert A. Dowd and Frank W. Curtis. 293 pages, 6 in. by 9 in., illustrated, bound in cloth. Published by the McGraw-Hill Book Company, Inc., New York.*

There are very few railroad shopmen who do not have occasion from time to time to design jigs and fixtures. For all who are called upon to do such work, this book, which is written by men who have had long experience in practical tool engineering, should prove helpful. It furnishes information regarding the principles of design of tooling arrangements which has heretofore not been available in books. In manufacturing plants as well as in railroad shops tools are worked out more or less by using ideas in vogue in the plant where the work is being done and lack of familiarity with the principles which should govern the design or the various methods which can be used to accomplish a given object lead to improper design.

The book opens with a discussion of considerations in the design of parts to permit easy tooling. The features to be considered in the design of jigs and fixtures are taken up in detail and many helpful suggestions are given. The subjects discussed in this volume include jigs and fixtures for drilling and milling machines, vise jaws and vise fixtures, and broaches and broaching fixtures. Various types of jigs in each subdivision are taken up in order, the discussion of the design, details of attachments, such as clamps, indexing fixtures, etc., and the classes of work for which they are best adapted. A large number of illustrations are used throughout the book which are helpful in obtaining a clear understanding of the principles set forth in the text.

FIXTURES FOR TURNING, BORING AND GRINDING. *By Albert A. Dowd and Frank W. Curtis, 340 pages, 6 in. by 9 in., illustrated, bound in cloth. Published by the McGraw-Hill Book Company, Inc., New York.*

This is a companion volume to "Jigs and Fixtures" by the same authors, being a discussion of important factors affecting the design of tools and fixtures for turning, boring and grinding operations. A careful study of the book can hardly fail to accomplish the purpose of the authors in affording a thorough understanding of fundamental points in jig design so that the reader can establish a substantial foundation on which to develop his own ideas. The subject is treated in a clear-cut, concise method, greatly clarified by numerous well-chosen illustrations.

The opening chapter is devoted to a discussion of engine lathe tooling, other chapters of particular interest to railroad shop men relating to turning tools and attachments for turret lathes; also boring, facing and recessing tools. Special fixtures for holding irregular work in vertical lathes and boring mills are described at some length, and methods of laying out and developing tools for machining tapered and curved surfaces are described. The last chapter contains much valuable information regarding fixtures for grinding.

This book is written by two authorities on the subject in question and should prove of much practical assistance to railroad shop men. Railroad shops are greatly in need of more jigs and fixtures for facilitating machine operations and many of the jigs and fixtures now in use need to be redesigned in accordance with correct principles. This book should prove an important aid in giving a correct understanding of these principles.

RAILROAD ELECTRIFICATION AND THE ELECTRIC LOCOMOTIVE. *By Arthur J. Manson, Manager Transportation Division—New York, Westinghouse Electric & Manufacturing Company. 332 pages, 6 in. by 9 in. 149 illustrations, 19 tables, bound in cloth. Published by Simmons-Boardman Publishing Company, New York.*

The early electrification projects might be considered as somewhat specialized in character but the success of the first experiments led to further extensions and the present trend of the development of economic as well as the purely mechanical features of railway operation indicates a constant tendency toward an increasing use of electricity as motive power. These facts make the specific information contained in this book, especially valuable to officials and employees of railway mechanical and electrical departments.

In a brief way, the author touches first upon some of the outstanding and most important advantages which may be expected to result from the electrification of existing steam railway facilities, either of an entire system or of certain sections of the line. Four chapters are devoted to explaining the underlying theory of common electrical phenomena, particularly those which relate to the application of electricity to railway operation. Five chapters are then given over to the explanation of the generally accepted types of motors used to supply power for electric locomotives. The principles of train operation are discussed and a comparison of the inherent advantages of electric and of steam locomotives is made.

The book contains an explanation of the various means used for accelerating and decelerating electrically operated trains. There are also included descriptions of the air brake equipment as applied to electrical locomotives and of the methods used for regenerative control. The principal features of electric locomotive design and the design of the transformer equipment are also discussed at considerable length. The last three chapters are devoted to the solution of an actual electrification problem dealing with the factors influencing the choice of an electric locomotive for an installation of a given character. Curves have been extensively utilized for illustrating the operating features and characteristics of motors, locomotives, and train service.

The book also includes an appendix which reviews briefly the history and salient features of various American electrification projects. Included in this section are eleven tables which show at a glance important characteristics and details of construction as applied to electrical operation of railways in every country where steam railways have been electrified, or where the initial installation was electrically operated.

The book does not discuss intricate technical details, but rather furnishes an outline which may serve as a basis for further study of these details. The information is of such nature and is presented in such a way as to be very valuable to those employees who are directly engaged in the maintenance of equipment on railroads which are already electrified or the employees of railroads which may be electrified in the near future.

A NEW MODEL of "couchette" sleeping cars for use on trains de luxe will shortly be introduced on the great international routes in Europe. Each carriage weighs 53 tons, and is entirely constructed of metal. The compartments contain only one berth each and are fitted with every modern convenience. A new type of second and third-class sleeping car for use on the French state railways has also been designed and will be run on the Paris-La Rochelle line.

The Cheyenne Erecting and Machine Shop, Looking from the Southeast

A Modern Medium-Size Shop at Cheyenne

Union Pacific Makes 15 Classified Locomotive Repairs a Month in New Plant Employing 570 Men

DURING a period of about three years prior to 1920, the Union Pacific carried out an unusually comprehensive program of engine terminal and shop improvements. A new 40-stall roundhouse was built at Council Bluffs, Ia., a new 35-stall house at Kansas City, Kan., and a new 14-stall house at Ellis, Kan. Fifteen additional stalls were built at Grand Island, Neb.; 28 at Green River, Wyo., and 20 at Junction City, Kan. Coaling stations, varying in storage capacity from 400 to 650 tons, were also included in the new terminal facilities at Council Bluffs, Ia.; Grand Island, Neb.; Kansas City, Kan., and Junction City, Kan. At Sidney, Neb., a new coaling station was the only extensive improvement made. With the coaling station at Council Bluffs is combined the cinder disposal plant, so that the same conveying system which handles the coal also elevates the ashes from the three ash pit tracks to a storage bin over the coal receiving track.

In addition to the facilities for turning and storing locomotives, the program included new machine and erecting shops at Council Bluffs, Ia., Green River, Wyo., Junction City, Kan.; Ellis., Kan., and Evanston, Wyo. The shop buildings at Council Bluffs, Ellis and Green River are each 70 ft. wide by 200 ft. long, with a machine bay 39 ft. wide and an erecting bay with one longitudinal track, 30 ft. wide, which is served with a 20-ton crane. The shops at Junction City, Kan., and Evanson, Wyo., are 108 ft. by 209 ft., and 100 ft. by 150 ft., respectively.

These shops have materially increased the independence of the terminals at which they have been built with respect to caring for heavy running repairs. To provide additional capacity for classified repairs, the program included two projects. The principal back shop at Omaha was increased from two buildings of similar cross section, with a combined length of 711 ft., to a single unit 1,011 ft. long, containing a three-pit erection shop of the longitudinal type, each pit having a length of about 700 ft. At Cheyenne, Wyo., was built a complete new erecting and machine shop. This shop is the transverse type, with 16 pits.

The Cheyenne shops are located at about the center of the road and, with a monthly output of 15 classified repairs, are designed to take care of the general repairs on about 240 locomotives of all classes operating on the west end of the main line. In addition to the back shop work, the machine shop also serves the Cheyenne roundhouse for all running repairs and takes care of the store order work for the two western divisions of the main line. Except for heavy firebox work and the finishing of locomotive cylinders, it is practically independent of the main shops at Omaha. A force of about 570 men is employed in the back shops.

The new shop building at Cheyenne is of steel frame, brick curtain-wall construction. It is 410 ft. long by 195 ft. wide and is divided into three bays. The pits are 23 ft. between centers and the erecting bay is 82 ft. wide. Adjoining this on the east is the heavy machine bay 70 ft. wide, with a light machine bay 40 ft. 7 in. wide along the east side of the building. In a brick lean-to, 31 ft. wide by 207 ft. long, built against the east wall of the main shop building, is located the office of the shop superintendent and general foreman, the toilet room, the fans for the hot air heating system and the locker and lavatory room.

The clear height under the roof trusses of the two west bays are determined by the requirements of crane headway. In the light machine bay the clear height is 20 ft. The heavy machine bay is served by two 20-ton Whiting cranes, operating on tracks 20 ft. 6 in. above the floor and the height under the roof trusses is 36 ft. 8 in. The erecting bay is also served by two 20-ton cranes, operating on tracks at the same height as those in the heavy machine bay, and in addition, is equipped with one Whiting 250-ton crane, the tracks for which are 44 ft. 6 in. above the floor. In this bay the roof trusses clear a height of 56 ft. 8 in. The roof over the erecting bay is of the monitor type with movable sash in the

sides. Over the two machine bays the roofs are of the longitudinal saw-tooth type, providing three rows of windows over the heavy bay and two over the light bay, all facing the east.

The building is heated by the hot air system, using two 85-in. Bayley fans, each with a heating plant of five Chinook steam heater units. The hot air is distributed through conduits under the shop floor and delivered into the shop space through sheet metal outlets rising six feet above the floor level.

The fact has already been mentioned that the new building houses only the machine and erecting shops. One of the drawings shows the relation of the new to the old buildings still used to house other departments of the locomotive shops. Extending along the east side of the new building from near its north end is the old machine and erecting shop building, which is now connected with the new building by an annex at the north end. The tank shop utilizes the pits at the north end of the old building and the tin shop occupies the east half of the middle section of this building. The remainder is occupied by the boiler shop with the flue welding equipment laid out along the west side of the building at the south end. The annex between the two buildings is occupied by the air brake department.

In a wing extending out from the east side of the old shop are located the engine room, containing the transformers and switch boards controlling the distribution of electric power, which is purchased, the welding generator sets, and air compressors. Adjoining the engine room are a toilet and a tool room. In the east end of the building is the electrical shop. The blacksmith shop still occupies its old quarters in the easternmost building of the locomotive group.

The power plant contains eight 256-hp. and two 236 hp. Sterling boilers with La Clede chain grate stokers. The power plant is provided with Link Belt coal and ash handling equipment.

The new shop is provided with both alternating and direct current circuits. The alternating current power circuits are three-phase, 60 cycles at 440 volts. The direct current circuits, supplying the cranes and some of the heavy tools, are 230 volts. The shop lighting is taken from 220 volt, three-wire, alternating current circuits, using 115 volt lamps in the new shop and 230 volt lamps in the old shop.

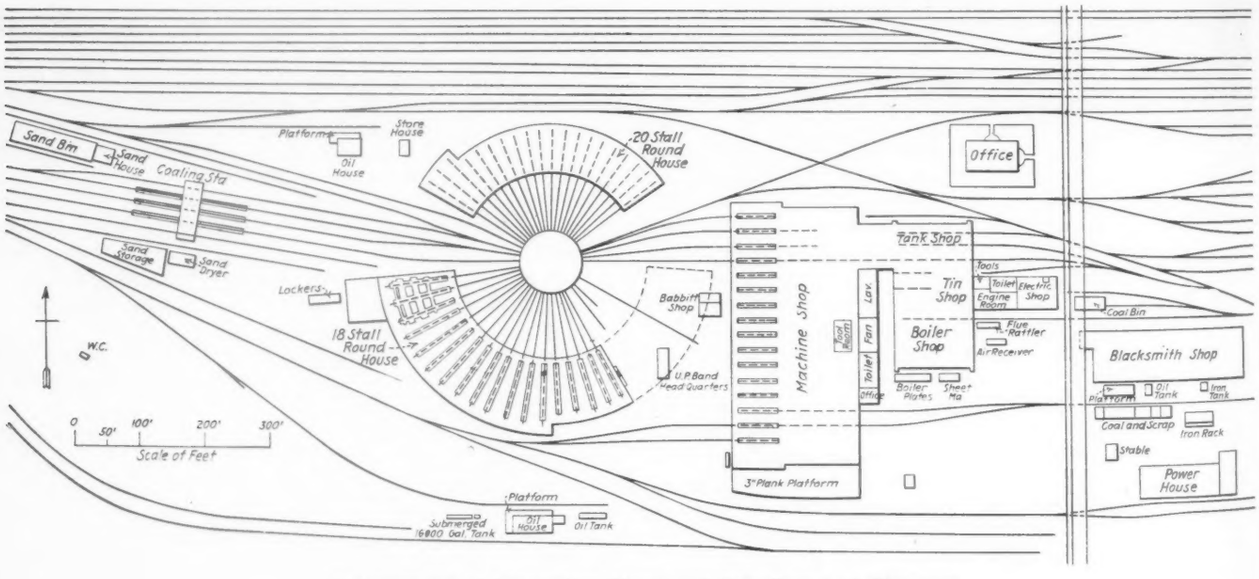
The welding equipment is located in the engine room adjoining the old shop building. It consists of two sets, each made up of a Westinghouse type CS 94-hp. induction motor, directly connected to a type KS 60-kw., 60-volt, 1,000 amp., d. c. generator. The two sets are used to relieve each other. The welding circuits for the machine shop terminate in four control boards located at columns between the erecting and heavy machine bay, each serving an additional outlet, thus giving eight points from which welding leads may be run. An additional control board is located in a room complete enclosed at the end of the shop in which all electric welding on portable work is performed in order to avoid the necessity of setting up temporary protection at each job.

The shop is also piped with acetylene and oxygen, the acetylene gas being supplied from a generator station in an outside building. Water, steam and gas connections are provided at alternate columns on both sides of the erecting bay with the locations on the two sides staggered. Air connections and two outlets for light cords are provided at each column on both sides of the bay and power outlets are located at alternate columns on the inside only.

The Erecting Shop

The erecting shop includes 16 transverse pits, which are operated without a transfer table. The pits are numbered consecutively from the north towards the south. The first four pits are fitted with doors and are connected directly to the turntable of the roundhouse, which adjoins the new shop building on the west. Only two of these tracks are regularly used, however. The second and third pits are kept open for stripping and finishing operations, and are not regularly occupied by locomotives undergoing repairs. A locomotive entering the shop on one of these tracks is stripped and then moved to its assigned pit with the 250-ton crane. The tracks from these pits extend across the heavy machine bay. The driving box work is done at this end of the shop and on these tracks the finished wheels are assembled and the boxes fitted. A track from the fourth pit extends completely across the new shop and through the annex into the north end of the old locomotive shop. One of the principal uses for this track is the transportation of flues to and from the boiler shop. Neither this nor the two through tracks near the south end of the shop are regularly used for locomotive movements.

The erecting shop force is organized into four specialized gangs, each in charge of a foreman. The stripping gang



Arrangement of Locomotive Shops and Roundhouse at Cheyenne

removes all rods and motion work, the superheater units, air pumps, steam pipes, air drums and the cylinders and frames, where necessary. The gang is composed of about 20 men and the only mechanics included are an electric welder and a cutter. This gang cleans and distributes all parts to the points where repairs are to be made. The foreman then reports the new material needed to the general foreman, who, after receiving a similar report from the boiler foreman, furnishes the information to the store department. The frame gang does all work pertaining to the frames and their attachments, and applies the cylinders and guide yokes. This gang lays out and applies the shoes and wedges, takes care of the spring rigging, wheels the engine, leaving it in tram with the binders up, and puts up the brake rigging. The intermediate gang applies the steam pipes, superheater units, air pumps, main reservoirs and the front end and stack. It takes care of the dome work, including the throttle rigging. It also rebuilds and applies the engine trucks and trailers and looks after all boiler studs. The finishing gang bores out or applies valve chamber and cylinder bushings, grinds in cylinder heads, lines up the guides, applies the pistons and crossheads and sets the valves. It erects all motion work and applies the reversing gear and all cab fittings. The rod and link gang puts up its own side rods, but aside from this it does no erecting shop work. Requiring this gang to put up the rods has been found to lead to a keener sense of responsibility for corrections of tram than exists where this work is left to one of the regular floor gangs.

General View of the Heavy Machine Bay

Machine Shop

The machine shop organization is roughly divided into a light and heavy machine department with a foreman in charge of each. The light machine department includes the tool room. In addition to these two general gangs, the rod and link gang occupies the south end of both machine bays and the driving wheel work at the south end of the erecting bay, and the driving box repairs at the north end of the heavy machine bay are also separately supervised.

The general arrangement of the machine tools is shown on one of the drawings. The light machines are divided into two groups by the tool room, which is located in the light machine bay near the center of the shop. South of the tool room is a group of small engine and turret lathes, including two Jones & Lamson semi-automatic flat turret lathes. North of the tool room are two Brown & Sharpe universal millers, a 16 in. by 6 ft. engine lathe and a No. 13 Brown & Sharpe grinder, all employed in the manufacture of tools. The remainder of the tools in this group are made up of shapers and drill presses and an old horizontal milling machine. The latter machine has been fitted with a special boring bar and is utilized in boring out the babbit lined bearings in engine truck and trailer brasses. The group of tools at the north end of the light machine bay is used principally by the shop repair gang.

The smaller planers are grouped in a battery at the south end of the heavy machine shop. Adjoining the planers is a group of tools largely employed on pistons and crank pins. In addition to four engine lathes, this group includes a Gisholt 24-in. turret lathe which is employed in roughing out and threading crank pins on store orders. A Niles horizontal double-head key seat drill is used for milling crosshead and piston rod key ways. Piston rods are finished by grinding on a Norton 18-in. by 96-in. plain grinding machine.

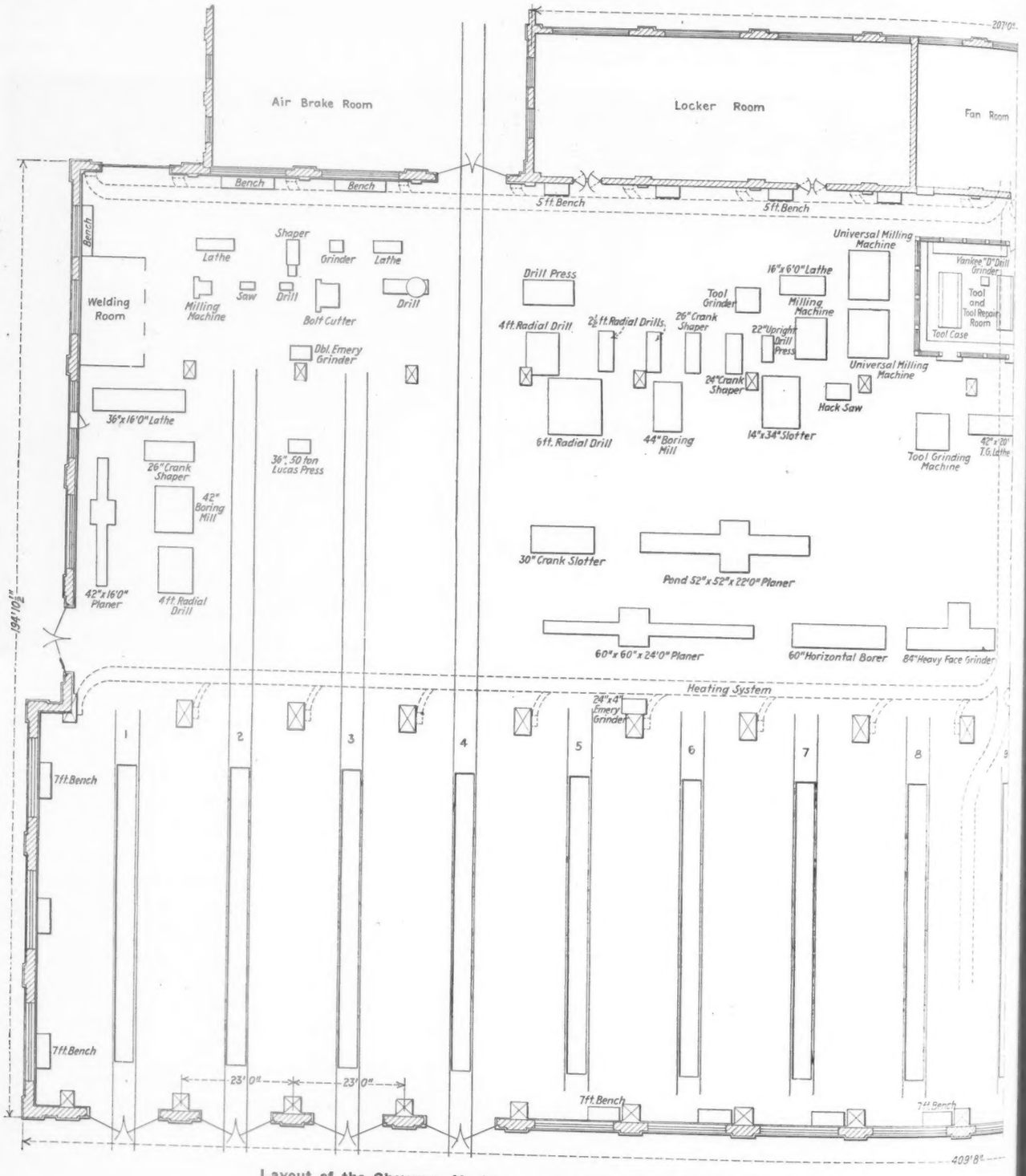
North of this group are located the heavy planers, a heavy slotter for driving box work, the guide grinder and a 60-in. horizontal boring mill. The largest of the planers is a new Niles 60-in. by 60-in. by 24-in. machine. The slotter, which was also installed new in the new shop, is a 30-in. Niles tool. The character of the work handled on this machine is shown on one of the illustrations.

The horizontal boring mill is used principally in milling to size the port openings in valve cages. The method of performing this operation is shown in one of the photographs. A rose end cutter, the diameter of which is equal to the finished size of the port openings, is inserted in the end of the boring

bar and the bushing is set up on the table of the machine. The cutter, adjusted to the proper height, is then fed successively into the ends of port opening sections and the cuts finished by rotating the table. By this method a port can be finished complete in from 13 to 20 minutes, the time depending more on the capacity of the cutter than on the operation of the machine itself.

On the east side of the heavy machine shop are located the boring mills, heavy lathes and heavy radial drills. Among the new tools in this group is a Niles 53-in. by 20-ft. lathe, a 6-ft. semi-universal radial drill and a Niles 44-in., double head boring mill.

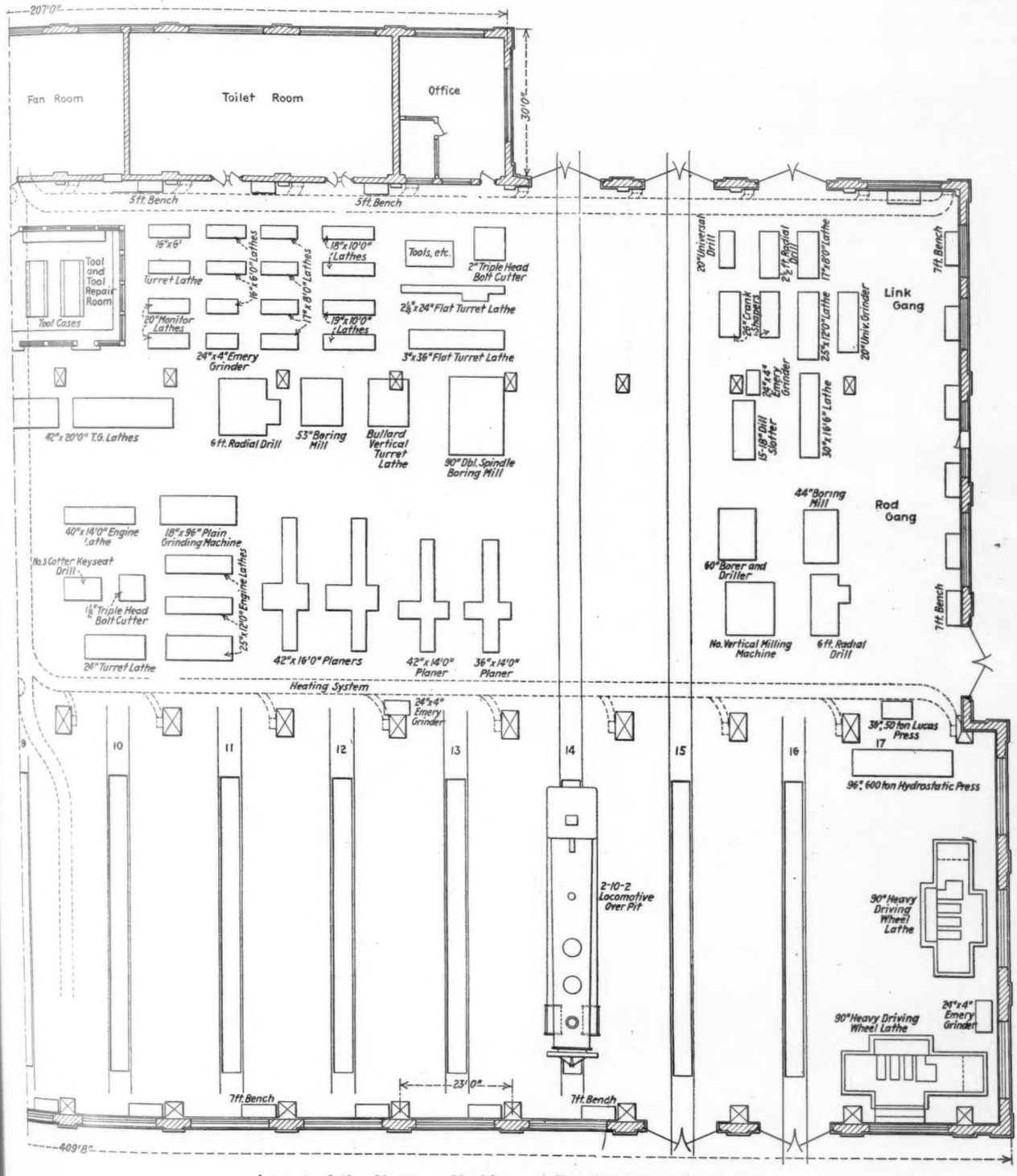
The majority of the tools in the rod and link department are new. These include two 26-in. Stockbridge crank shapers; one 17-in. and one 25-in. LeBlond engine lathe, the smaller of which is portable; one 30-in. Morris radial drill; one Niles 6-ft. full universal radial drill; an 18-in. slotter; a Niles 44-in. double-head boring mill and a Niles, No. 10 vertical milling machine. The latter machine, shown in one of the photographs, is used in finishing the contour of rod



Layout of the Cheyenne Machine and Erecting Shops—North End

ends, slab milling rods of rectangular sections and milling side rod jaws. The old Niles drill press, shown in another illustration, has been fitted with special boring cutters for finishing to size the inside of rod bushings and knuckle pin fits in side rod jaws. The set-up for boring out a back end

With the exception of one group of two old machines, neither of which is regularly used, every machine tool in the new shop is direct motor driven. Both alternating and direct motors are used. All of the planers, part of the shapers, the small lathes, grinders, bolt machines, boring mills and power



Layout of the Cheyenne Machine and Erecting Shops—South End

main rod brass, clamped in place in the strap, is shown in the illustration. In addition to the rod and motion work for the back shop, this department handles a considerable volume of work for the Cheyenne roundhouse as well as on store orders.

presses are fitted with constant speed A. C. motors. Most of the heavy machines, including the large engine lathes and some of the shapers are driven by direct current motors. Variable speed, alternating current motors are used on the new Niles 90-in. wheel lathe and the new vertical milling ma-

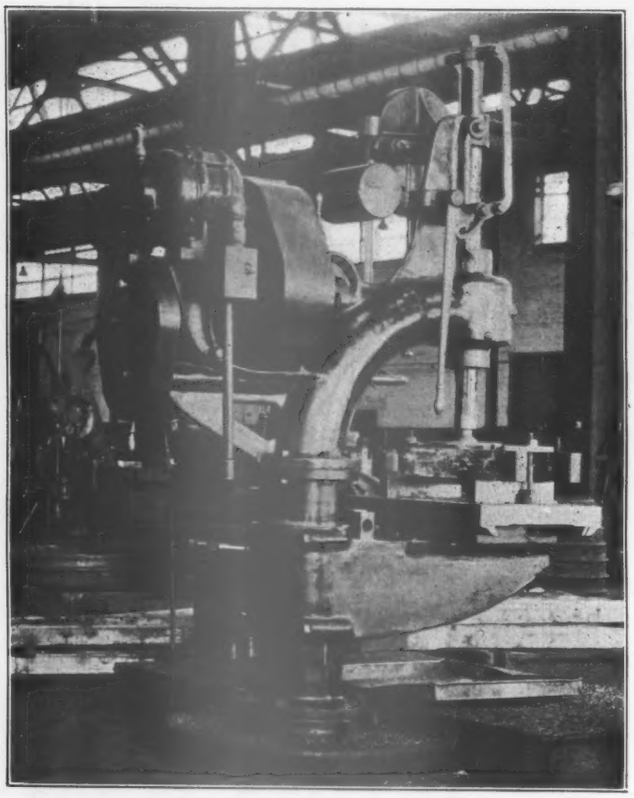
chine. The wheel lathe is fitted with push button control with a contactor panel for regulating the speed. The vertical milling machine is equipped with a controller and resistance.

Flue Shop

The boiler shop occupies the southern portion of the western half of the old locomotive shop building, adjoining the tank shop and both the tank and boiler shop are served by a crane which travels throughout the length of the building on the west side. Since the principal shops of the Union Pacific at Omaha are equipped to take care of the heavy firebox work for the system, no provision for this class of work has been made in the Cheyenne boiler shop, and the most interesting feature of this department is the flue shop.

Referring to the general layout of the locomotive shops, it will be seen that a track enters the east side of the old shop building toward the south end, and that the flue rattler is located adjacent to this track just outside the building. This track adjoins the north end of the flue shop, which extends south to the end of the building, along the west side.

Tubes removed in the erecting shop are loaded in cradles of the usual form, which are handled by crane to the through track from pit No. 4 of the erecting shop. Here they are placed on a shop lorrie which is pushed through to the boiler shop where the sling is again moved by crane to the flue shop track, to be moved again by lorrie to the rattler. From the rattler the tubes are again loaded in a cradle and moved

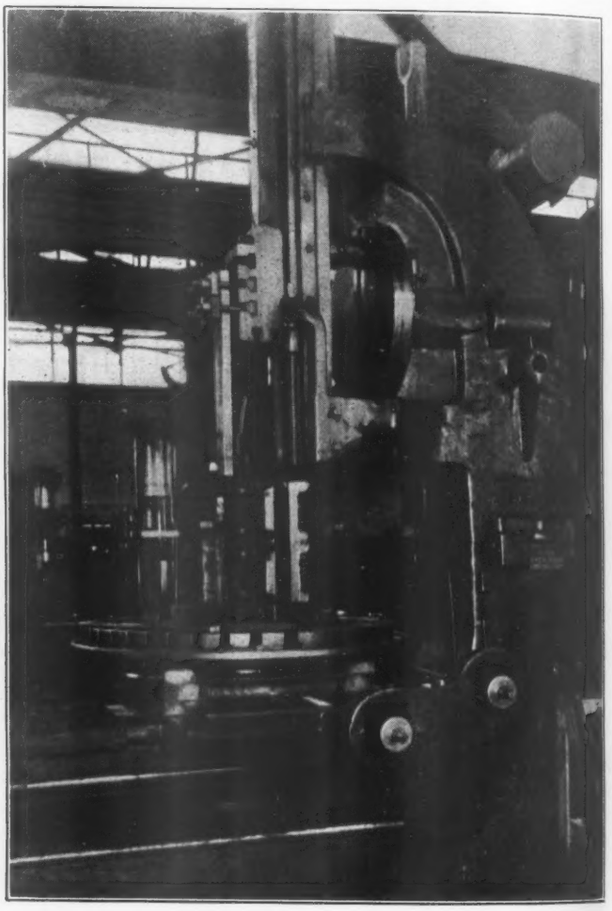


Old 60-in. Boring and Drilling Machine Used for Finishing Rod Bearings and Knuckle Pin Fits. Tools Are of the Milling Cutter and Reamer Types

back under the crane in the flue shop where they are moved to the south end of the shop by the crane. They then progress northward with no conflicting movement, until they are completed ready for movement by crane to the through track near the north end of the building, on which they are returned to the erecting shop.

At the south end of the shop are located the superheater flue welding facilities. These are of the usual type employing the Draper pneumatic welder. The equipment for safe ending the smaller tubes, which adjoins the flue equipment, in order of its location, consists of a combined tube cutter, reamer and grinder, a Federal electric safe end welder and an O'Neil roller. For swaging the back tube sheet ends, a Ferguson furnace and Draper pneumatic swaging hammer are provided. At the north end of the group is located the hydraulic tester.

The combined cutter, reamer and grinder is an effective shop-made device. It consists essentially of three spindles, two of which are driven from the same belt and the other separately driven from the motor shaft to provide for the



Driving Box Crowns Are Finished on a Niles 30-in. Crank Slotter

relatively lower speed required by the reamer. The cutter is of the ordinary roller type fed down by a hand screw. The tube, after the end has been cut off, is passed through a pneumatically operated clamp in front of the reamer spindle. By pressing a foot lever, air is admitted to the clamp cylinder and the pipe fed against the cutter, which finishes the inside of the tube ready for the application of the safe end. If the condition of the tube so requires, it is then entered in the grinding head, the loose emery blocks in which are closed against the tube by a foot lever operated clutch. The tube and safe end are then clamped in the pneumatically operated copper electrode jaws of the electric welder and forced together by a hand lever. From 45 seconds to one minute is required for complete fusion and the weld is finished in the roller.

Along the side of the shop just back of the electric welder is an old turret lathe which has been fitted up for cutting safe ends. The tube, which is fed through the spindle of the machine, is cut off by a tool on the cross slide, the contour of which provides the required external taper on the end of the safe end. A tool on the turret is then set forward into the

end of the tube to remove the wire edge produced by the cut-off tool.

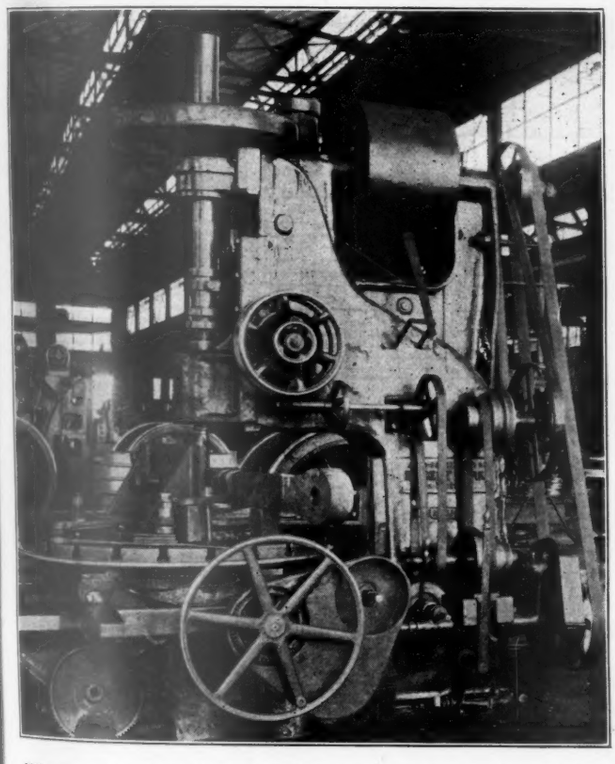
Not including the operation of the swaging hammer, the continuous operation of the plant, including the preparation of the tubes and safe ends, the safe ending and the testing requires six men.

Crane Signal System

Few shops ever have enough crane service. Whatever facilities may be provided, there are usually times when the demand for service is so heavy that more or less delay occurs, even though at other times the cranes may be idle. This condition has been encountered in the Cheyenne shop even though there are two cranes over the heavy machine bay and three over the erecting bay.

This led to a careful study of the service required at various parts of the shop in order that a means of more effectively utilizing the crane time might be worked out. As a result, what might be termed the center of density of the area served by each crane was determined and this point established as the station for that crane when not on call. This has eliminated a considerable amount of waste crane movement and materially speeded up the answering of calls.

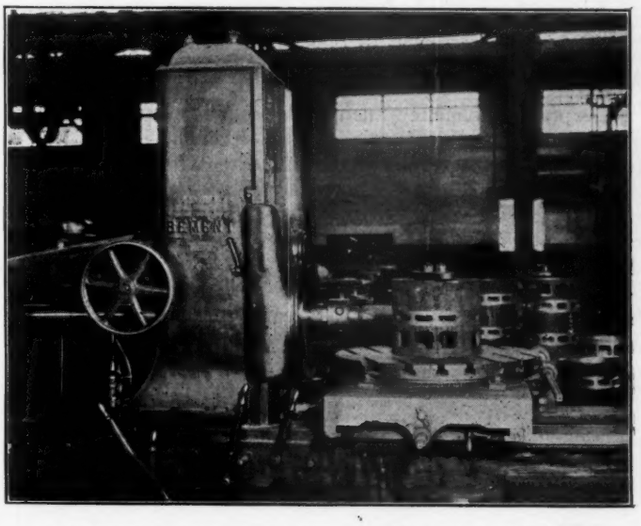
To further systematize the crane service and avoid the



Niles No. 10 Vertical Miller Finishes the New Side Rods and Stubs

confusion and loss of time of shouted calls or trips from various parts of the shops to personally advise a craneman that a job is waiting for him, a system of crane signals has been installed. These signals consist of red lights, one for each pit in the erecting shop and at approximately similar locations in the heavy machine shop. In the erecting shop the lights are located on the outside wall at the height of the crane operator's cage and are controlled by two three-way switches. When crane service is desired at a certain location in the shop, the light for that pit is turned on at the lower switch, which is accessible from the floor. When the crane operator responds to the call, he turns out the light at the switch accessible from his cage. This relieves the mechanic on the floor of further responsibility with respect to the signal after the crane has answered the call.

In the machine bay the signal lights have been placed at the top of the heavier machines, rather than at the higher location adopted in the erecting bay. This arrangement requires that the man who calls the crane must not fail to turn off the light as soon as he has been served. As the lights are within the range of vision of a man on the floor, however, this has not entailed any serious difficulty. In both cases the use of the lights has enabled the crane operator to keep clearly in mind the order in which calls are made and in case of two or more at the same time the foreman has an

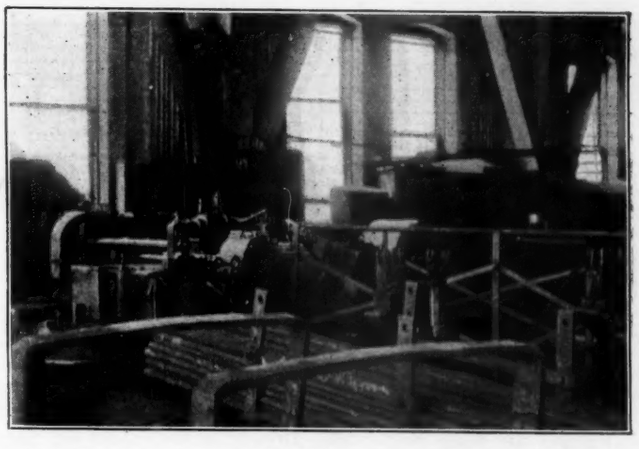


Horizontal Boring Mill Does a Quick Job of Finishing Bushing Parts

opportunity, if he so desires, to determine the priority of the service.

The "Red Cap" System

A simple and practicable system of communication between the various departments of the shops and the stores department, to facilitate prompt delivery of material, has been developed at the Cheyenne shops. This embraces not only the locomotive shop but also the roundhouse, the car shops and the freight car repair tracks. Small sheet metal pockets have



The Flue Cutter, Electric Welder and Roller With Safe End Machine at the Rear

been provided at 34 stations, in which the foremen can deposit their orders for material. These pockets are all painted red and numbered serially from 1 to 34, inclusive. A number of messengers assigned to this service, make the rounds of these stations once every half-hour, carrying the material slips collected from the pockets to the store house. In making out a material order the foreman notes on it the num-

ber of the station at which he desires to have the material delivered. The orders are then sorted and filled, and the material called for and each is delivered by the store department to the designated station.

There are six stations in the new locomotive shop, three in the old shop, one in the electrical shop, two in the blacksmith shop and nine in the roundhouse. The remainder are located at various points in the car shops and on the repair tracks. This service is locally designated as the "red-cap" system because the plan ultimately contemplates providing the messengers with red caps in order that they may be readily accessible to the foremen as they make their rounds.

Man-Hour System for Determining Shop Efficiency

A simple man-hour system has been developed for comparing the overall efficiency of the locomotive shops, one period with another. Three forms are required for compiling the man-hours expended on each locomotive, running repairs, store orders or tools, and recording the results by locomotive classes. Form No. 1 is filled out at the close of each day's work by each gang foreman. On the three lines opposite the number of each engine in the shop at the time, he notes the time worked by each mechanic, helper or apprentice, as the case may be, and enters the sums of these

UNION PACIFIC SYSTEM
UNION PACIFIC RAILROAD CO. Form Temporary No. 1
GANG FOREMAN'S DAILY REPORT OF MAN HOURS WORKED

LOCATION _____
REPORT FOR _____ 192__

GANG _____
FOREMAN _____

Locomotives receiving classified repairs Eng. No. (1)	Class of employes (2)	MAN HOURS WORKED — MAN HOURS REPORTED ON TIME CARD FORM 5034 FOR THIS DAY (3)	Total for day (4)	Previous day's grand total (5)	Grand total to date (6)
	M				
	H				
	A				
	M				
	H				
	A				
	M				
	H				
	A				
	M				
	H				
	A				
	A				
Running repairs	M				
	H				
	A				
Store orders	M				
	H				
	A				
Tools	M				
	H				
	A				
Misc.	M				
	H				
	A				

Instructions: This form to be made out daily by each gang foreman and forwarded to general foreman's office with time card, Form 5034.
Man hours worked on classified repairs to be carried forward each day until repairs are completed. Man hours worked on running repairs, store orders, tools and miscellaneous to be computed from first to last of each month only.

"M" Mechanics
"H" Helpers
"A" Apprentices

Date _____ Gang Foreman _____

Gang Foreman's Daily Man-Hour Report

amounts in the column headed "Total for Day." In an adjoining column headed "Previous Day's Grand Total," is contained the total man-hours already accumulated on the locomotive up to the current day. The sum of these two columns is entered in a third column entitled "Grand Total to Date," and before turning in the form the foreman enters this figure in the "Previous Day's Grand Total" column on his next day's form. The totals for locomotives receiving classified repairs are carried forward until the locomotive is turned out of the shop, irrespective of monthly periods. The totals expended on store orders, running repairs, tools and miscellaneous are accumulated by monthly periods only.

It has been found that by having the foreman fill out these forms instead of having it done in the office, the foreman is enabled to keep a better check on just what each one of his men is doing, as well as on the accuracy with which they are filling out their time-cards. It also affords the foreman a constant reminder of the total number of hours worked by his men on each engine. This is of assistance in keeping his work on schedule as well as in maintaining a satisfactory relationship between the total number of man-hours that have been worked and the actual amount of work that has been accomplished.

The second form is compiled in the office from the reports turned in by the foremen, a column being provided for each

UNION PACIFIC SYSTEM
UNION PACIFIC RAILROAD CO. FORM Temporary No. 2.
GENERAL FOREMAN'S DAILY REPORT OF MAN HOURS WORKED BY GANGS

LOCATION _____
REPORT FOR _____ 192__

Locomotives receiving classified repairs Eng. No. (1)	Class of employes	MAN HOURS WORKED — SHOP OR GANG: Machine; Erect'g; Red & Link; Pipe & Tin; Air; Boiler; Black-smith; Sheet Iron; Electric; Pr. Plant; Drop Pit	Total for day (2)	Previous day's grand total (3)	Grand total to date (4)
	M				
	H				
	A				
	M				
	H				
	A				
	M				
	H				
	A				
TOTAL MAN HOURS WORKED ON CLASSIFIED REPAIRS TODAY					
Average number of men working on classified repairs today (Foregoing item divided by 8)					
Running repairs	M				
	H				
	A				
Store Orders	M				
	H				
	A				
Tools	M				
	H				
	A				
Misc.	M				
	H				
	A				

Instructions: This form to be made out daily from information compiled on Form Temporary No. 1

"M" Mechanics
"H" Helpers
"A" Apprentices

General Foreman

General Foreman's Daily Man-Hour Report

gang in the shop. In the columns headed "Total for Day," "Previous Day's Grand Total," and "Grand Total to Date," show the totals for the entire locomotive department for the periods designated.

After the repairs on a locomotive are completed, the final total, taken from the second sheet for the day that the locomotive is turned out of the shop, are posted to a large sheet, one of which is provided for each class of locomotives. In addition to the total classified man-hours for each gang and the grand total, this sheet shows the dates in and out of the shop, the number of working days during the period and a notation of any unusual repairs which may have been included. It gives the shop superintendent in permanent form a detailed comparison of shop efficiency for various periods by comparing locomotives of identical construction with each other.

For overall comparison of one month or one year with another, the total man-hours expended on classified repairs may be compiled and checked against the aggregate tractive effort which is probably the most accurate unit available that eliminates all variations in the size and capacity of the locomotives that may have been turned out of the shop during the periods under comparison.

Shop Scheduling

A comparatively simple shop scheduling system is employed in the Cheyenne locomotive shops. Although not elaborate in detail, the system is highly regarded by the shop foremen and is considered to be better fitted to the comparatively small organization required by an output of approximately 15 locomotives per month than one requiring clerical service in its operation.

The control board, which is of the customary form with the engine numbers shown in the right hand vertical column with parallel columns headed by the various scheduled operations, is located in the general foreman's office and is

FORM Temporary No. 4

UNION PACIFIC SYSTEM
UNION PACIFIC RAILROAD COMPANY

SCHEDULE FOR SHOPPING LOCOMOTIVE _____

SET IN SHOP _____

TO _____
Foreman

CLASS REPAIRS	BOILER WORK	CYLINDER	FRAMES

DATE AND TIME TO COMPLETE

1	2	3	4	5	6	7	8
ALL STRIPPING MACHY & BOILER	FLUES IN	CAB COCKS AND THROTTLE	TEST BOILER	FRAMES	SHOES AND WEDGES PLANED	DRIVING BOXES FITTED	WHEELS UNDER

9	10	11	12	13	14	15	16	17
CROSS HEADS LINED	LINES HUNG	RET. GEAR IN PLACE	MAIN RODS UP	VALVES SET	UNITS TESTED	ALL RODS IN PLACE	PIPING	OUT

Machine work on Driving Wheels and Boxes, Rods, Motion Work, Cab Cocks, etc., must be ready to comply with the above dates.

If unable to complete work on date specified full explanation must be written in space below, referring to number.

_____ (Date)

_____
General Foreman

Foreman's Copy of the Shopping Schedule Furnished for Each Locomotive

filled out by him or the shop clerk from a master schedule as each locomotive enters the shop.

In addition to this board, only two forms are used. The first of these is filled out in the office for each locomotive entering the shop and, in addition to a detailed description of the work to be done on the boiler, the cylinders, and the frames, it shows the completion dates of all operations listed on the control board.

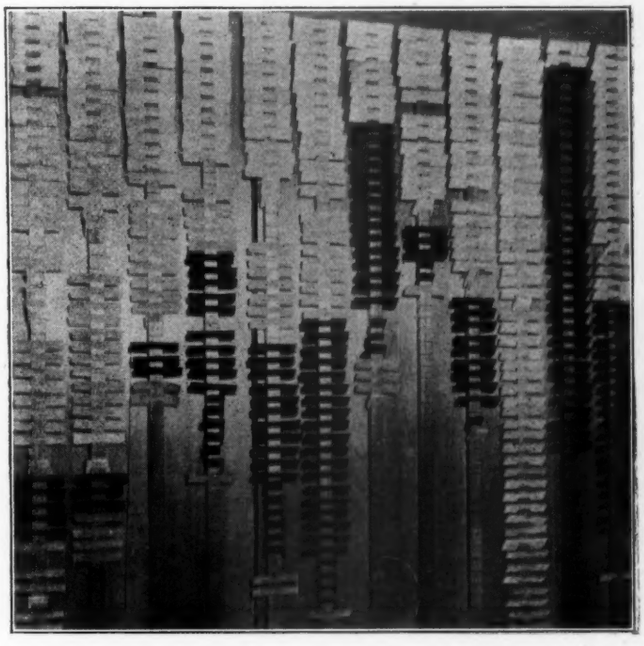
A copy of this form is furnished to each foreman, who thus has on file a record of the completion dates for his work and other work on which his own depends, for all locomotives in the shop.

The other form is a locomotive delay report which is filled out by the general foreman and sent to any foreman whose operations are behind schedule. The foreman receiving one of these slips is required to fill out the form at the bottom, showing the time that the delayed operation will be completed, and return it to the general foreman. In actual practice, this form is not used as a means of advising the general foreman when the operation will be completed so much as it is as a reminder to the foreman whose operations are behind that he is being watched.

Similarly, in a shop of this size, the control board finds its principal use as an aid to the general foreman in planning for changes in the schedule when unexpected conditions arise affecting the completion time of some particular locomotive, rather than in keeping track of the day to day progress of the work. When changes of this kind are made, each foreman receives a copy of the revised schedule for the locomotive or locomotives involved.

Visual Roster of Shop Employees

On the wall of the shop superintendent's office is a visual record of the entire force employed in the locomotive shop. By reference to the photograph it will be seen that it is a large wood panel on which are mounted 21 vertical raised strips, each containing about 50 slots wide enough to receive a heavy paper card. One of these cards is made out for each man employed in the shops, on which is shown his classification, the date he entered the service and his hourly or monthly rate. The names of all mechanics are entered on white cards, apprentices on blue cards, helpers on red cards and laborers on pink cards. Each vertical strip is assigned to a gang, with the foreman's card at the top, followed in order by the cards for the mechanics, apprentices, helpers and laborers. When an employee leaves the service his card is folded and reinserted on the board. When his place is filled, the folded



A Section of the Visual Roster of Shop Employees

card is removed and destroyed. By this means it is possible to tell at a glance the number of men in each classification employed in each gang and the number of vacancies in each classification in each gang.

On a similar board located in the outer office where it is accessible to all employees, a duplicate set of cards are arranged by employment classifications in seniority order. The cards are two inches long and about three-quarters inch wide.

EIGHT IMPORTANT railway lines have recently reported additions to their postal car equipment of 91 new steel cars for use as traveling railway post offices, according to an announcement made by the Post Office Department. The new mail cars, constructed according to the latest designs, will facilitate the handling of mails where they are used and will also provide greater safety for clerks working in them. The following railroads have informed the department of the construction of new steel cars: Baltimore & Ohio, 8; Boston & Maine, 5; Chicago & North Western, 5; Chicago, Burlington & Quincy, 32; Colorado & Southern, 5; Fort Worth & Denver City, 4; Pennsylvania, 25; Southern, 25.

Grinding Air Cylinders

THE modern internal grinder, illustrated, has been recently installed in a prominent railroad shop and is used among other things for truing worn air compressor cylinders. Fig. 1 shows a general view of the machine with the air cylinders bolted to the right-angle knee bracket on the machine table. The grinding wheel of large diameter is being used in the 14½ in. low pressure cylinder to which the exhaust hood for removing metal and abrasive dust is connected. The cylinders are made of cast-iron and it takes about 10 minutes to line them up on the machine table. The average time required to finish grinding the large cylinder is one hour. Fig. 2 shows the grinding wheel in the 8-in. high pressure cylinder which can be ground in approximately 40 minutes, depending on the cylinder wear and the amount of metal which must be removed to produce a true cylinder. Fig. 3 gives some idea of the high finish secured by grinding and also shows the dust exhauster applied to the high pressure cylinder.

There is no question as to the value of grinding for this particular operation wherever a modern internal grinder of ample power and accuracy is available. Accurate, smooth, cylinders are vital to air compressor efficiency and no machining process has yet been developed which is equal to

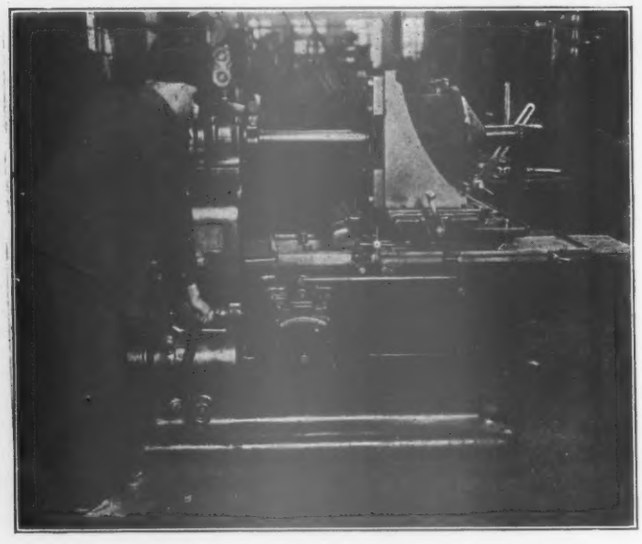


Fig. 1—Modern Internal Grinder Truing Low Pressure Air Cylinder

grinding as regards these two particulars, accuracy and finish. The grinding operation requires less time than other methods, and in addition, only enough metal is removed to true up the cylinders with a consequent increase in cylinder and bushing life.

Comparison of Grinding and Boring

Substantiation of the above statements was afforded in a test recently made by truing worn New York 9½-in. by 12-in. air compressor cylinders on a modern internal grinder worth about $3,000 and on an up-to-date boring mill in good condition worth about $8,000. An all day run was made. The test showed that in the case of grinding, about 1/16 in. of stock was removed; the setting up time averaged 18 min. and the grinding time 45 min.; the finish was excellent. On the boring machine ¼ in. of metal was removed, the setting up time averaging 20 min. and the grinding time one hour and twenty minutes. The finish was not as smooth.

The boring mill removed ¼ in. of stock to get the cutting tool under the surface, whereas the grinder simply cleaned up the cylinder, removing only 1/16 in. of stock. This is a feature which is much appreciated since the cylinders can be trued more times by grinding than they can by boring before being bushed. Experience on the road in question also showed that the ground cylinders would run about twice as long as those which were bored owing to the superior finish. The relative values of the two machines also had a noticable effect on the cost of truing cylinders.

Internal cylinder grinders can be used for many other purposes besides grinding air compressor cylinders in railroad shops and some of these uses will be described in a subsequent issue. In all cases, railroad men should take advantage of the engineering service offered by the manufacturers in maintaining the grinders in the best possible operating condition and giving advice in case of difficulty and when undertaking new work.

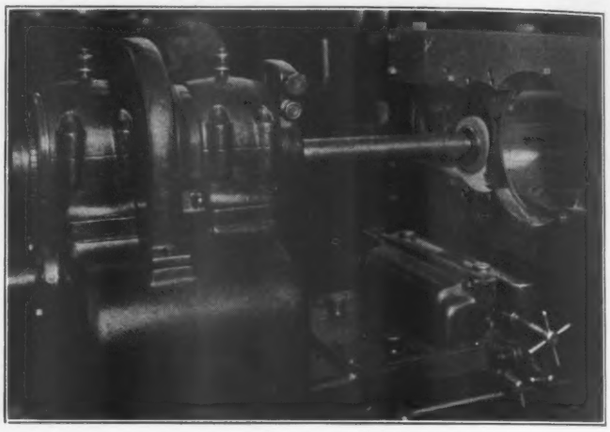


Fig. 2—View Showing Grinding Wheel in High Pressure Cylinder

In one case, for example, a cylinder grinder had been installed and was producing work entirely satisfactory as to quality but not as to production. Between four and five hours was required to grind a single 9½-in. by 12-in. air compressor cylinder, removing 1/16 in. of stock. On learning of this condition, the manufacturer immediately sent to the shop a representative who from long experience was soon able to locate the difficulty and show the shop force how to grind 9½-in. cylinders in one hour each, floor to floor. The possible uses of the internal grinding machine have since been developed to such an extent at the shop in question that another machine will be needed in the near future.

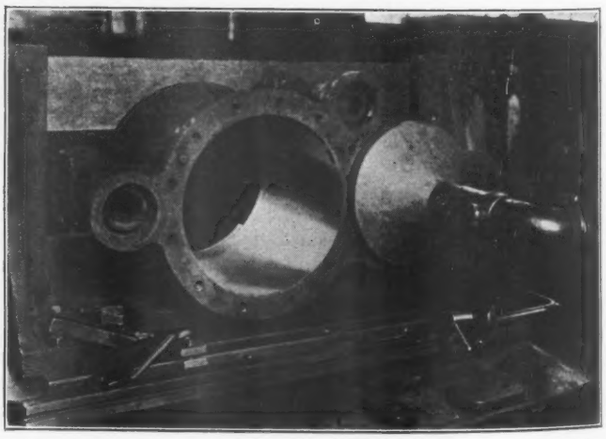


Fig. 3—The Arrangement for Exhausting Metal and Abrasive Dust While Grinding Is Important

Fig. 1—Machine Section of Shop and Steel Storage Space

Steel Car Construction on the Canadian Pacific*

Special Machinery and Erecting Jigs at Angus Shops for Economical Manufacture of Freight Cars

By H. R. Naylor
Assistant Works Manager, Angus Shops

A COMPARISON of the modern 60-ton steel-frame box car with the 30-ton wood-frame box car commonly built fifteen years ago brings out two points: The complete change in design, and the effect this change in design must have had on the car shops. It is obvious that the facilities for building the wood-frame car would be quite inadequate for the steel car and must have created new problems with which the car builder had to contend; and it is the intention to deal with this phase of steel-car construction, especially as the Canadian Pacific was responsible for many of the important developments.

Development of the Steel-Frame Box Car

The gradual increase in locomotive capacity, making possible the hauling of longer and heavier trains, subjected the wooden cars to severe service conditions, which were in turn met by steel under-frames and other steel reinforcements; and at each stage of advancement wood framing was gradually replaced by steel, until in 1909 the Canadian Pacific originated a box car having the entire frame built of steel.

Within a period of six years (1909-1914) this road added 30,841 steel-frame box cars to its equipment and others soon adopted a similar design. After ten years of extensive service these cars had evidently proved their utility, for the United States Railroad Administration in one order alone included no less than 50,000 of this type.

The earlier steel-frame box car, was built with center sills of 15-in. channels, side sills of 8-in. channels, side and end posts of 4-in. Z-bars, and corner posts of 5-in. angles. The longitudinal sheathing was bolted to the inside of the framing, in which elongated holes were punched to allow the boards to be retightened without removing the bolts. This feature, however, has since been discontinued, as there is a possibility of the joints between the boards reopening if they are not effectively checked.

The New Steel-Car Shop

The Angus shops were already well equipped for building passenger and freight cars on an extensive scale, the large shops having supplementary planing mills, gray-iron and wheel foundries, and blacksmith, machine, and truck shops capable of supplying the greater proportion of all materials required. The output of wood-frame box cars at these shops had reached as high as 40 cars per day. This organization, however, was rendered obsolete to a large extent when the Canadian Pacific introduced the steel-frame box car necessitating the erection of an additional shop. This shop was designed for building the steelwork of both passenger and freight equipment, and embodied in its arrangement many novel features for the rapid handling of material. At the time of its erection it probably represented the best practice on this continent, being a combination of the good features observed in other shops with the original ideas developed at the time the layout was being planned.

The freight section of the shop was designed to construct steel-frame box cars in the most economical manner, and although some minor modifications have been made in the machinery layout and erecting equipment to meet subsequent developments, the shop has well served the purpose for which it was intended.

The new shop was located adjoining the wood-freight-car shop, facing a midway upon either side of which were also located the supplementary shops, the midway being served with overhead traveling cranes. It is a steel-frame structure, with steel columns carried on concrete piers, the lower foundation walls being of concrete, above which the walls are of red brick. The sash frames are of steel, the total sash area being approximately 40 per cent of the total wall space. The roof is carried on steel trusses with ample skylight

*Abstract of a paper presented at the spring meeting of the American Society of Mechanical Engineers, Montreal, May 28, 1923.

area. The floors are of 4-in. concrete with a top surface of 5/8 in. mastic.

There are three main divisions to the shop. The front one, facing the midway and occupying the entire front, is the machine section, consisting of two 100-ft. bays running parallel to the midway, the one adjoining the midway being 209½ ft. long, while the inner bay is 182 ft. long. Each bay is served by a 10-ton electrically operated crane having a span of 96¼ ft., and a height to base of rail of 28½ ft.

The freight-car erecting section is situated in the rear of the machine section, is 72 ft. wide and 405 ft. long, and was originally equipped with one 10-ton traveling crane having a span of 67½ ft., and a height to base of rail of 27 ft. An additional crane of similar capacity has since been installed.

Situated also to the rear of the machine shop is the passenger-car erecting section, consisting of four bays having a total width of 110 ft. These four bays with the 72-ft. freight-car bay complete the full width of the back of the machine shop. Each bay of the passenger-car section is provided with a separate 2-ton traveling crane having a span of 24 ft. 10 in. and height to base of crane rail of 21 ft.

Along the entire front of the shop, between it and the midway, there is ample provision for storing material. This storage yard is 100 ft. wide and is served by a 10-ton crane whose span and height are identical with those in the machine section in anticipation of future shop extension. This crane runway extends beyond the shop limits and spans several tracks where cars of material can be readily switched and unloaded.

Through the freight-car erecting shop, entering from the rear end, are two standard-gage tracks 48 ft. center to center which extend the full length but do not enter the machine shop. Outside the shop and parallel to the south wall a standard-gage track connects with a track on the midway through turntables. This track is used for delivering the car trucks from the truck shop to the assembly tracks.

Through each of the passenger-car erecting bays there is a standard-gage track leading in from the rear of the shop, also a transfer table for moving the cars during the various stages of completion. Through the center of the material storage yard, there is a standard-gage track connecting by turntables with three tracks running into the machine shop.

Fig. 2—Freight Car Erecting Section at Right, Passenger Car Erecting Section at Left

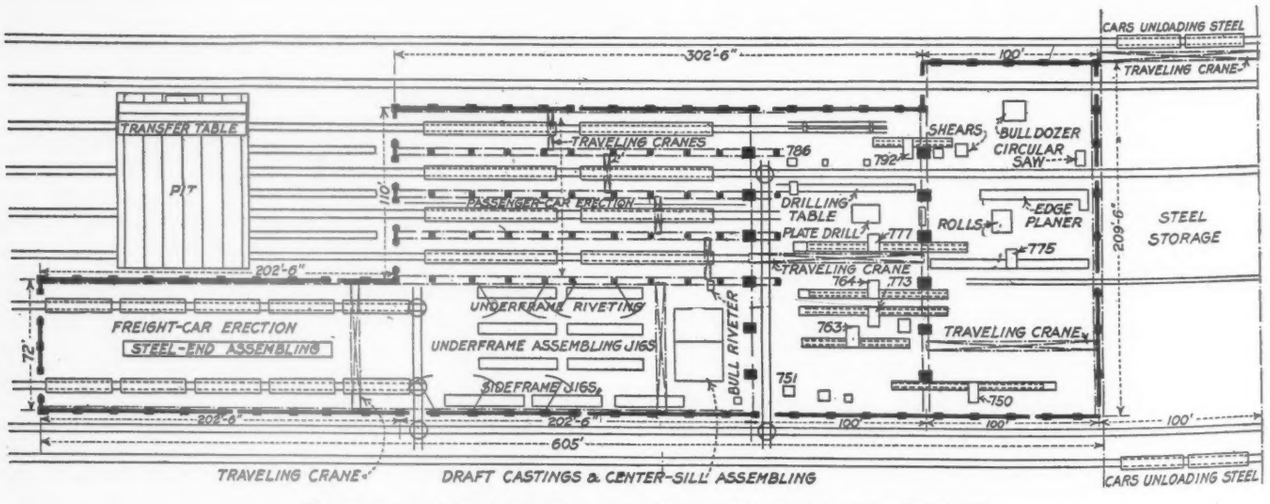


Fig. 3—Plan of Steel-Car Shop, Canadian Pacific Angus Shops, Montreal

The Crane Facilities

The crane facilities are unique in that the whole area of the shop is traversed by electrically-operated traveling cranes so arranged that it is possible to install an unusual number, and yet maintain for each crane complete free-

dom of operation at all times. The crane arrangement was the deciding factor in the shop layout. It was decided that the machine section should be independent of the erecting sections insofar as crane service was concerned, and for this reason the crane runways in this section were installed in a direction transverse to those in the erecting shop. This made it possible to equip the two machine bays with separate cranes, each having a wide range of action with no interference.

The machine layout is arranged with the view of relieving the overhead cranes to the greatest possible extent. This applies particularly to the handling of the larger members, such as center and side sills which are required to pass over two punching machines situated in the different bays. As the first operation is completed the sills are transferred to the second machine by special devices independently of the metal templets are made up and into which holes are drilled; by inserting a pin or gage in each successive hole and butting the plate against the pin, the desired spacing is obtained. In certain classes of work the operator can move the material fast enough to catch every hole with the punch running at the rate of 60 strokes per minute.

An unusual plan was followed as regards the installation of machines for heavy punching. The usual practice had been to install a small number of high-capacity machines for punching and slotting sills, side plates, and similar members, necessitating frequent changing of dies and templets, with further limitations in the event of breakdowns. It was therefore decided to overcome these handicaps by installing four automatic spacing punches of moderate capacity to obviate the expense and delay of die changing and double handling, and as the five additional

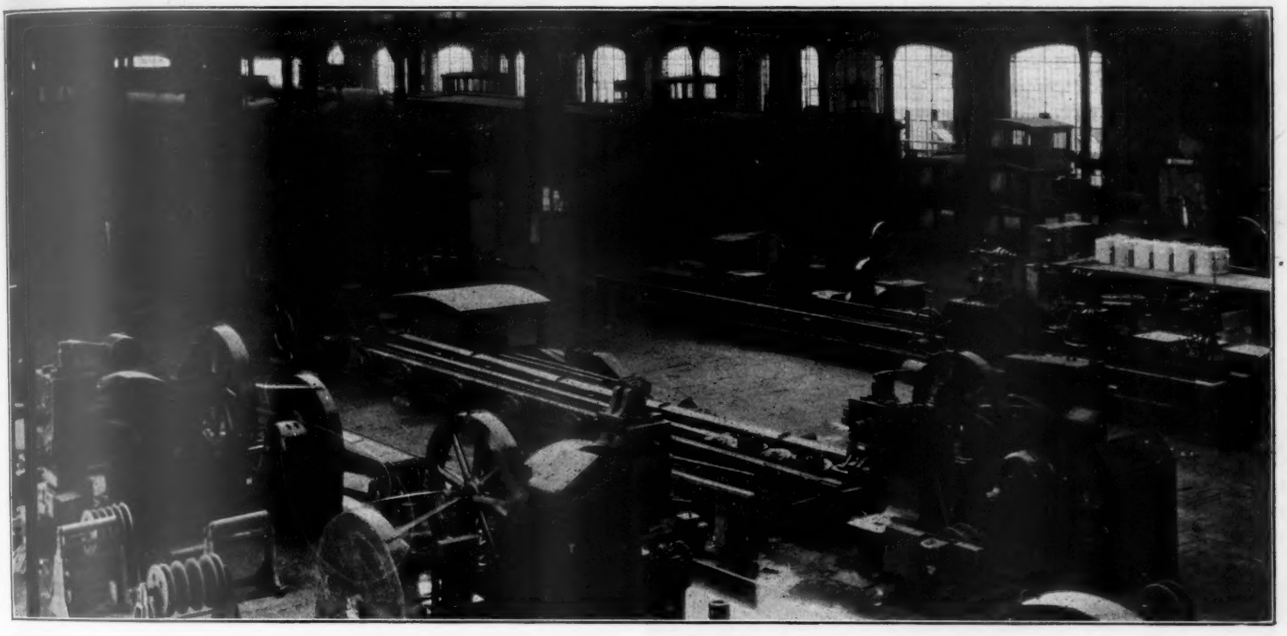


Fig. 4—Interior of Machine Section Looking Toward Erecting Section

cranes. On completion of the machining operations the sills are then skidded to the assembling trestles in the erecting shop without assistance from the cranes.

The two cranes in the freight-car erecting shop, operating on the same runway, are entirely free from machine-shop handling, and as the first one is assigned to the preliminary assembly positions and the second to the final assembly positions, there is no overlapping or interference.

The Machine Equipment

The machine shop is equipped with the following machinery: Four automatic spacing punches, five coping punches, five high-speed punches, two horizontal punches, one 7-ft. 6-in. gate shear, one angle shear, one 36-ft. plate-edge planer, one 30-in. circular saw, one 30-in. metal band saw, one 7-ft. plate roll, one 10-ft. brake, one bulldozer, two special plate-drilling machines, and miscellaneous drill presses, all driven by independent motors.

The arrangement of the machines is such that the material after each operation moves forward in the direction of the erecting shops, backward movement being carefully avoided, thereby reducing material handling to a minimum.

The high-speed punches are belt-driven direct from motor to flywheel, gears being dispensed with. Clutches are of the 6-point type. The heads are equipped with two punches which are controlled by gag levers. These machines are well adapted for punching the smaller plates for which coping punches are duplicates of those used in the automatic spacing tables, replacement can be made with but short delay should they become disabled.

The Machining Operations

The yard in front of the shop is used for storing the larger members such as sills, cover plates, side plates, etc.; the smaller parts such as the posts and braces, bolster and cross-bearer diaphragms, etc., are made by bulldozers and hydraulic presses in the blacksmith shop.

The machines are served by narrow-gage service tracks running from the material storage yard, special care being taken to unload the material close to the track by which it will enter the shop. The progress of material through the machine shop is as follows: Center sills and side-sill channels are loaded by overhead crane and brought into the shop on service lorries and deposited on trestles opposite the traveler at rear of center- and side-sill web spacing punch No. 775. Two air-operated traversing jacks lift the sills in pairs and place them on the traveler rollers ready to pass through the machine. On the far side of this punch, is an elevated runway carrying the traveler head which grips the sills with its projecting jaws and automatically spaces the punching. Along the traveler runway steel templets with projecting pins engage a trip lever suspended on the head of the traveler, close the electric circuit, arrest the travel of the head, and close the circuit of the punch control;

the punch then completes the operation. After passing through this machine the sills are released from the jaws of the traveler, lifted by jib cranes and deposited back to back on the rollers of sill-flange spacing punch No. 777, which are placed directly opposite the delivery end of the web punch. On completion of the first operation the sills are disengaged from the head clamp and pushed back over the rollers to the starting point, where they are again turned over by a special device attached to the jib cranes and passed through the machine for the second operation on the opposite flanges. The sills are then lifted by the traveling crane of the inner section of the machine shop and placed on the rollers of coping punch No. 763 directly opposite, where draft-key and lever slots are punched, completing the operations on the sills.

The center-sill and body-bolster cover plates and similar plates are punched on spacing punch No. 750. The side plates are punched on automatic spacing punch No. 764 in a similar manner to the sills, passing through for the first and second operations in pairs.

In all these operations the passage through the machines is rapid and the accuracy of the spacing mechanism is such that the punching error is slight and far less than it would be were each hole marked off and punched independently.

There are certain parts which cannot be handled satisfactorily on the spacing punches, yet the punching must be equally as accurate or otherwise much of the benefit obtained from the spacing punches is lost when the parts are assembled. The machining of the ends of the side posts and braces is an example of this kind. In this case special combination dies are used to shear the ends to shape and punch the group of holes in one operation.

Fig. 5—Center and Side-Sill Web Spacing Punch

The bolster cover plates and diaphragms are machined in a similar manner, the cover plates being passed over the spacing punch and the diaphragm flanges punched in one of the coping punches equipped with special dies for punching the flange holes in one operation. During these operations the machine is relieved of excessive load by varying the length of the punches, resulting in the holes being punched consecutively.

The usual practice for freight-car work is to punch rivet holes to a diameter not exceeding that of the rivet, and, when the parts are bolted together, to ream the holes to a size not exceeding that of the rivet by more than 1/16 in.

The Jig Method of Assembly

The erecting of steel frame box cars by the jig method was originated at the Angus shops. By this method the underframes, side frames, and end frames are assembled on jigs as complete units ready for the final assembly of the car. The jigs consist of stands or cradles by means of which the various members are accurately placed and held in proper relation to each other until they are riveted together. The advantages of this method are manifold. As each member lies flat in the jig the drawing together of the parts is reduced to a minimum, wedge bolts being used extensively for this purpose as they can be rapidly applied. A complete unit being assembled in one operation, the possibility of a cumulative error is avoided. The jigs dispense entirely with checking for squareness, alignment, and location of connection holes, thereby simplifying the final assembly to a considerable extent.

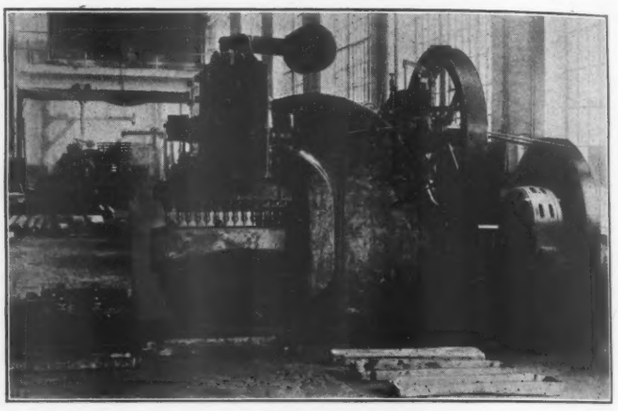


Fig. 6—Coping Punch for Punching Holes in Flanges of Bolster and Cross Bearer Diaphragms

Before any of the parts are assembled, all concealed surfaces are painted to prevent corrosion.

The center-sill channels after passing through slot-punching machine No. 763 are skidded from the idler rollers to trestles just inside the erecting shop, where the draft castings are temporarily bolted on and the holes reamed ready for riveting. An electric hoist operating on a runway below and clear of the overhead cranes, swings the sills into position and the draft castings are riveted on by a compression riveter. The individual sills are then moved across to a position on the left where the two center sills are assembled and riveted with bolster center castings and separators in position. The sills are placed on stands on which are four fixed pins corresponding to four rivet holes in the sills at the center line of the bolsters. By placing the sills flange down on these pins perfect alignment of the two sills in assured, which simplifies the application of cover plates later on. The draft gear is also applied in this position.

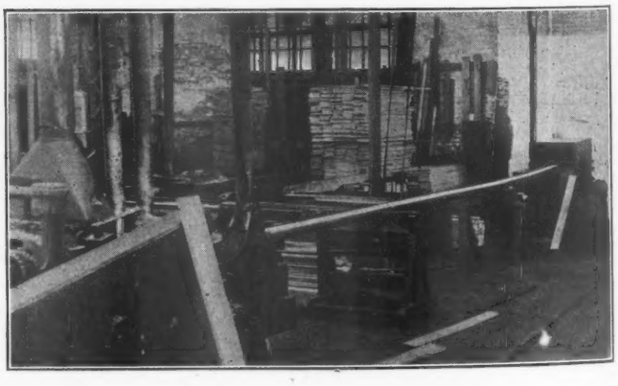


Fig. 7—Boards Leaving Matcher and Passing Automatically Through Painting Machine

The next step is the assembling of the underframes, and

as this is a lengthy operation, four positions are assigned for the purpose. These jigs, consist of four steel cradles located at bolster and cross-bearer centers, and so arranged that each member of the underframe is held in proper alignment and at centers that will coincide exactly with connections on the side frames. The bottom cover plates of the bolster and cross-bearers are first placed on centering pins; the overhead crane then places the center sills in position, to which are attached the bolster and cross-bearer diaphragms with their cover plates and center-sill cover plate complete, after which the assembly is bolted together and the holes reamed ready for riveting.

The underframes are then swung over by the overhead crane to the riveting jigs on the right, which are constructed similar to those used for assembling, thereby maintaining the proper alignment. Each riveting position is equipped with two 50-ton compression riveters suspended from swinging jib cranes, the posts of which are in line with columns to the right. The crane jibs are 21 ft. in length with runways for air hoists, the suspension mechanism being so arranged that the riveters can be tilted to drive the rivets in the inclined bottom flanges of the bolster and cross-bearers which otherwise would have to be driven by an air hammer. The compression riveters were specially designed on the scissors principle, with a thin nose to permit of the top and bottom

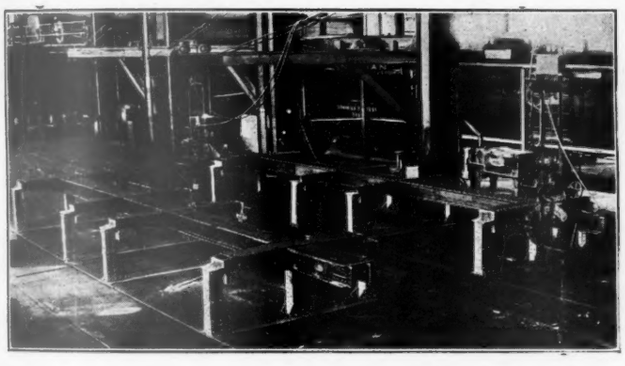


Fig. 8—Jig Used for Assembling Underframes

rows of rivets being driven without turning the underframe over in order to complete the operation.

The side frames, consisting of the side sill, side-plate, post, braces, door posts, and track, are assembled as a unit on a jig frame situated abreast of the underframe jigs. This jig consists of channel-iron stands, the four corner ones of which are capped with short sections of channel iron in which are holes for locating exactly the side sills and plates. The stands on either side are tied together with angle bars which carry additional cross-bars upon which the various members of the side frames are placed in proper relation to each other. In this position the side frame is temporarily bolted, reamed, and riveted ready for the final assembly position.

Originally the end frames were assembled on jigs similar to those used for the side frames, but in recent years the end-post construction has been replaced by corrugated-steel ends. These steel ends and the end sills are assembled on trestles located between the final assembling tracks, and when temporarily bolted together are skidded to the second and third positions where they are reamed and riveted. In the fourth position the end ladders, roof-frame brackets, and other parts are applied, the ends as completed being then placed opposite the final assembling position.

The Final Erecting

As the trucks are assembled and painted, they are delivered from the truck shop and enter the erecting shop by the side door immediately ahead of the underframe and side-frame jigs, where they are turned on a turntable and placed in position on the assembling track. The underframe completed on the riveting jig is then lifted by the overhead crane and placed on the trucks, the slings are released, and a steel end is next placed in position and bolted on the end farthest away from the side-frame jigs; the side frames are then placed in position, and finally the second end, along with the center and side-sill cross-ties. The brake-cylinder, reservoir and piping are also applied at this time.

The car is then moved by car haul to the second position where the assembled members and the roof framing are riveted in place. In the third position safety appliances, brake rigging, couplers, uncoupling rods, etc., are applied,

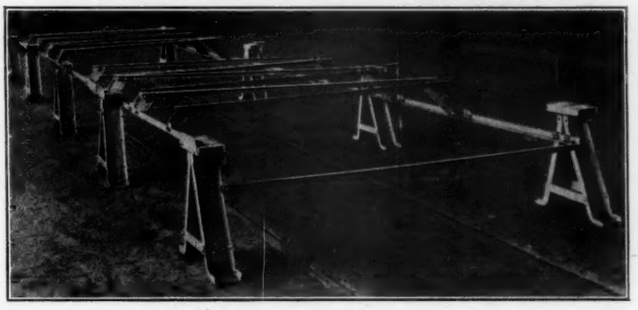


Fig. 9—Jig Used for Assembling Side Frames

the remainder of the riveting completed. The entire frame is then sprayed with the priming coat of paint ready for finishing.

Finishing the Car

The steel frames are switched each day to the wood freight-car shop where the decking, sheathing, roofing, and doors are applied and the painting operations are completed. The decking is of 1¾-in. red pine and the sheathing of 1½-in.

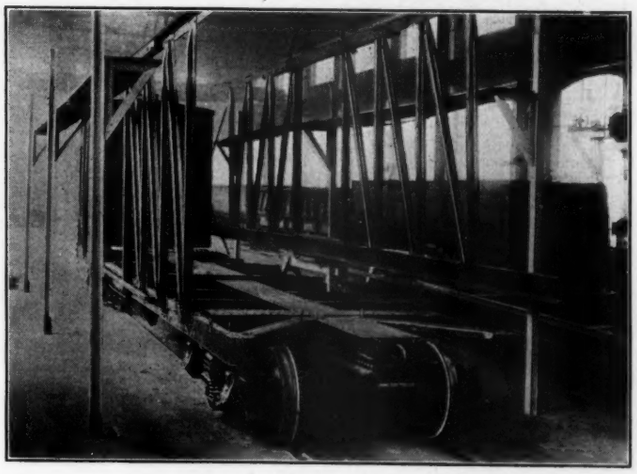


Fig. 10—Placing the Side Frames in Position

Douglas fir, both having tongued-and-grooved joints. High-grade lumber free from knots, checks, or cracks is selected for this purpose and is then kiln dried, the moisture content being carefully limited in order to prevent the further shrinkage later on; the only objection of any importance raised against the steel-frame box car, as compared with other box cars, having been one arising from improper drying of the sheathing. After being machined the sheathing is again examined, and any boards checked or cracked are set aside and used for lining the ends of the car.

Before leaving the planing mill the sheathing, roofing,

and running boards receive their priming coat of paint in a painting machine recently developed at the Angus shops and which differs from those in use elsewhere. The boards on leaving the matcher pass automatically through a painting machine where they are sprayed by a series of nozzles which can be set in any desired position according to the surfaces required to be painted. The paint is drawn up through

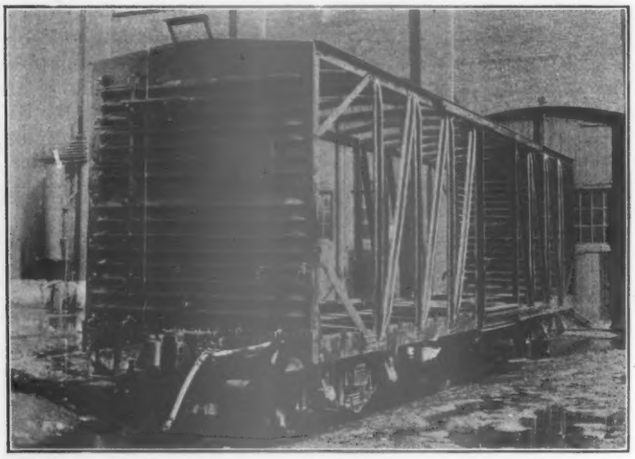


Fig. 11—Car with Steel Work Completed and Ready for Finishing

suction pipes by means of air jets blowing across the nozzles, and as ejected is atomized by the air and blown on to the boards in a fine spray. The amount of paint applied is controlled by air valves or by regulating the speed at which the boards pass through the machine. No brushing or wiping is necessary. The boards on leaving the machine are piled on trailer trucks and distributed by tractors to the

Fig. 12—Steel Frame Box Car Completed and Ready for Service

shops when dry. These machines will paint at the rate of 200 running feet per minute, which is about as fast as the boards can be conveniently piled for drying.

The first operation in the wood freight-car shop is to apply the decking, the joints of which are previously coated with a thick paint compound, as are also the ends of the boards making contact with the bottom boards of the side sheathing previously applied.

The side sheathing which has already received the priming coat of paint is next applied, and to insure that the sides of the car will be watertight, the joints are coated with paint compound, after which they are wedged down into position and bolted to the framing. The end lining is then applied in a similar manner but vertically. In the succeeding operation the roof is applied, the boards and metal sheets of which have previously been primed.

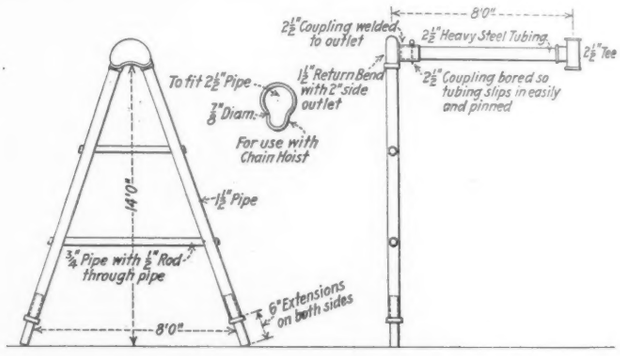
After the doors are hung in place and the remainder of the safety appliances have been installed, the car is given two additional coats of paint and stenciled, when it is complete and ready for service.

Removing Air Compressors

By W. F. Zwiehel,
Foreman, Air and Pipe Department, Central Railroad of New Jersey, Ashley, Pa.

FOR quickly and easily removing air compressors from locomotives while in a roundhouse or shop without crane facilities, the device illustrated will prove of value. It has already been used successfully in removing about 50 air compressors and will handle equally well the 9½ in. or the heavier cross compound type.

Briefly, the device consists of two triangular legs made of 1½-in. pipe joined at the top by a return bend to which is attached a horizontal piece of 2½ in. heavy steel tubing,


8'0"
2½" Coupling welded to outlet
2½" Heavy Steel Tubing
2½" Tee
To fit 2½" Pipe
1½" Return Bend with 2" side outlet
2½" Coupling bored so tubing slips in easily and pinned
7/8" Diam.
For use with Chain Hoist
14'0"
1½" Pipe
¾" Pipe with ½" Rod through pipe
6" Extensions on both sides
8'0"

Device for Removing Air Compressors from Locomotives

the height being such as to allow for a slip ring and chain falls between the horizontal tubing and the top of the air compressor on the largest locomotive. The legs are 8 ft. apart at the bottom and of such a length that the return bend is 14 ft. above the ground, a slight variation in this distance being obtainable by means of the 6 in. extensions on the legs. The legs are tied together by two ½-in. rods, over which pieces of ¾-in. pipe have been applied to serve as spreaders.

The return bend has a side outlet in which a 2½-in. coupling is welded, the latter being bored out to fit over the horizontal tubing which is held by a pin. The slip ring is a sliding fit on the horizontal steel tubing, being applied before the latter is pinned to the coupling. A tee is provided to hook into the sand dome or be chained in such a way that the device will not move while an air compressor is being applied or taken down.

NON-OBSERVANCE OF RULE 6 of the code of per diem rules, requiring subscribers to the car service and per diem agreement to make settlements for car hire with non-subscriber connections at the established per diem rate without any free time and without reclaim, has been complained of to the Board of Directors of the American Railway Association, and an appeal has been issued, calling upon the railroads to see that the provisions of Rule 6 are uniformly enforced. Non-observance results in discrimination as between non-subscriber railroads and in constant efforts of non-subscriber roads to obtain as favorable arrangements as may have been made with the few, all of which has a tendency to break down the entire per diem structure.

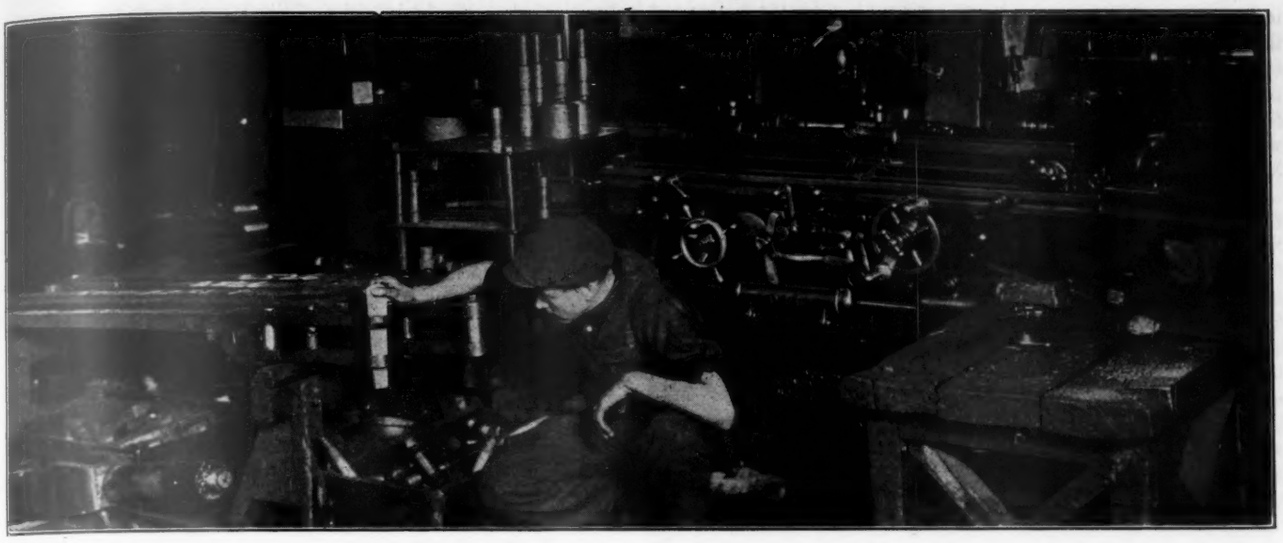


Fig. 1—Accurate Gaging and Grinding is Essential in Making Standard Pins and Bushings

Standardization of Locomotive Repair Parts

With Particular Emphasis on Methods of Standardizing and Machining Valve Motion Pins and Bushings

By M. H. Williams

LOCOMOTIVE repair shop work can be expedited and costs greatly reduced by standardizing new parts used in making repairs. Standardizing will enable certain surfaces, such as the body or bearing surfaces of valve motion pins and the bores of bushings, to be completely finished before it is known on what locomotive these parts will be used. Side rod knuckle pins and bushings, crosshead pins, crank pins, taper bolts and a large number of similar articles can also be standardized to a greater or less extent.

It is not contemplated that one standard can be set to cover all designs of locomotives, or that any radical change shall be made to existing standards. However, the possibility of reducing the number of designs of parts that must from necessity be frequently renewed should receive careful consideration. In many cases it will be found that slight modifications, not affecting the operation of locomotives, may be made to frequently renewed parts, enabling one design or size to be used on a greater number of classes of locomotives than is now the practice.

The principal requirement when standardizing is to make a careful study of present conditions and ascertain where designs of articles used for repairs can be modified, or several combined in one. In this way it is possible to manufacture each article in larger quantities, which in turn reduces costs. This is in line with the present demand that railroad shops turn out work as rapidly and economically as their size and equipment will permit.

Most railroad shops, when considered only as local units, are not large enough to warrant the installation of special production machines, such as automatic screw machines, automatic chucking machines, drop hammers for making drop forgings, forging machines, high-power milling machines, production grinding machines, etc. On railroads where standardization has been carefully studied and the number of designs reduced to a minimum, however, such machines can be economically employed in a single production shop, which supplies other system points with finished or semi-finished articles used in repair work.

The size of a railroad is the limiting factor. A railroad having only a comparatively small number of locomotives can not afford to install these special machines even when the work is concentrated in the largest shop of the system, and as a result, repair parts must be manufactured by relatively crude and expensive methods. Standardization on the smaller railroads with the object of reducing the cost of repair parts may at first glance seem impossible. As a matter of fact, if the parts are standardized, they may eventually be purchased in the open market.

Repair Parts Made by Outside Companies

There are in this country a number of locomotive builders, also manufacturing plants not necessarily engaged in locomotive work, which are well equipped for manufacturing locomotive repair parts. These companies would be glad to go into this business, providing the designs were standardized and orders from several roads could be combined, facilitating the manufacture of parts in large quantities. Repair parts could then be produced in a finished or semi-finished state, catalogued, and ordered readily by both large and small roads, much the same as repair parts for air brake equipment, injectors, lubricators, etc., are now ordered.

The standardization of certain parts used for the repair of locomotives is not as serious a problem as may at first appear. One method of standardizing valve motion pins and the machines shown by experience to be adapted for the purposes of making them, will be described. While this is not a new subject in the columns of the *Railway Mechanical Engineer,* it has been selected for treatment first owing to the large number of these pins required for repair work and the comparative ease of reducing them to a standard.

The valve motion pin, shown in Fig. 2, is representative of the great majority of these pins used on all classes of

locomotives, from 10 to 16 pins being required for each of the 68,000 odd steam locomotives in the United States. A conservative estimate would place the total number required for renewals at 250,000 per year, or the production of 7 of the most modern six-spindle automatic screw machines, each working 8 hours a day, 300 days a year, not including time lost for breakdowns, repairs, or set-up.

The ideal pin of this nature should be supplied to repair shops having the body or bearing surface *A* ground to specified sizes within a limit of plus or minus 0.001 in., the lengths being as specified by each railroad. The taper ends *C* and *D* should be rough turned, the larger diameter of taper end *C* with certain exceptions being of the same size as body *A*, the larger diameter of taper end *D* being turned to the taper extended from the small end *C*. Holes *E* and *F* for spline and cotter pins respectively are drilled; the ends threaded; centers drilled at both ends, and the pin stamped with a catalogue number. The grooves or recesses *G* and *H* are necessary to prevent shouldering when grinding. Where motion pins are to be casehardened, this operation can also profitably be done at the time of manufacture.

The bushings, used in connection with these pins, to be described later, should be casehardened and internally ground about 0.008 in. larger than the pin body which will in turn admit of 0.004 to 0.006 in. for a running fit on the pin when the bushing is forced into the lever. (This is the allowance shown in Fig. 2.)

When making repairs, all the work required is to machine the two taper ends of the pin and the outside of the bushing. As the body *A* of the pin and the bore of bushing have both been ground to the correct size to fit each other, no work is necessary on these two surfaces which will reduce

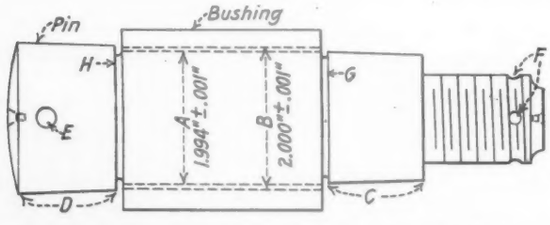


Fig. 2—Representative Type of Motion Pin and Bushing

the time required to make pin and bushing renewals about 75 per cent.

Casehardened and semi-finished pins and bushings cannot be turned at the time of making repairs and, therefore, must be ground. Experience has shown that the plain cylindrical grinding machine is best adapted for this purpose, not only for the above mentioned pins and bushings, but in addition for kunckle pins and bushings, crank pins, crosshead pins and a large number of articles either casehardened or soft. In fact, one of the principal arguments in favor of grinding is the reduction in time required to finish an article to the required size.

Establishing Standards

Referring again to motion pins, the ideal condition for quantity production will be when all locomotive valve motion levers are reamed for the same taper per foot, and the lengths of pins as well as their diameters are reduced to the fewest number of sizes.

Certain railroads have adopted a taper of one in. per ft. for all taper holes in valve motion levers, which appears to be the most satisfactory from a shop repair, roundhouse and service standpoint. It would be a good thing if this taper could be made universal. With many existing standards, levers have been reamed at the large ends to some arbitrary sizes, such as 1¾ in., 2 in., etc., to the foot, without due regard to the body sizes. When considering repair conditions and the useful life of levers, it would be desirable to ream each new valve motion lever so that the pin body will just pass through the larger reamed side of the jaw, as shown at *A*, Fig. 3, the smaller reamed side of the jaw being reamed to a taper extended from the larger side. Both sides of the jaw are thus reamed at one time. This design will admit of a greater amount of enlargement of taper holes at the time of repairs, or in other words the lever may be reamed a greater number of times before the smaller reamed side is as large as the body of the pin. Obviously, when

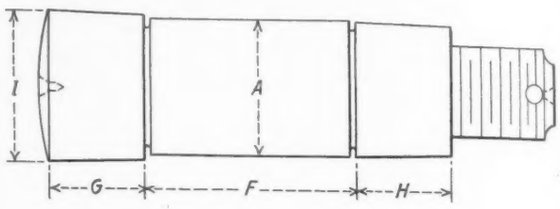


Table 1—Proposed Step Sizes for Valve Motion Pins

Step sizes	A	F	G	H	I
Standard ...	1.492 in.	2¼ in.	1⅛ in.	1⅛ in.	1 1/16 in.
A	1.492 in.	2¼ in.	1⅛ in.	1⅛ in.	1 3/16 in.
B	1.554 in.	2¼ in.	1⅛ in.	1⅛ in.	1 5/16 in.
C	1.617 in.	2¼ in.	1⅛ in.	1⅛ in.	1 7/16 in.

the latter condition exists, it is necessary to scrap the lever or resort to pins having larger bodies.

The possible exception to this design is in the case of extra long pins where the small ends become too small for a reasonable sized nut. While the adoption of pins of the design mentioned may cause a departure from existing standards, it will pay in the long run.

Step Sizes for Pins and Bushings

It would be difficult to set a hard and fast rule to govern step sizes most desirable for all designs of valve motion pins. Therefore the peculiar design for each class of locomotive must be a controlling factor. For relatively long pins having bodies 3 in. or greater in length and steep taper ends, it will in many cases be found that one diameter of body will answer for practically all repairs. In this event it is desirable to blank out the taper ends to step sizes, a system that has worked well being to make the steps 1/16 in., ⅛ in. and 3/16 in. larger than standard.

With shorter pins having a taper of 1 in. or less per foot, the taper holes in levers, owing to wear or re-reaming, are frequently enlarged so that the smaller of the two reamed holes of the lever jaw is equal to or larger than the body of

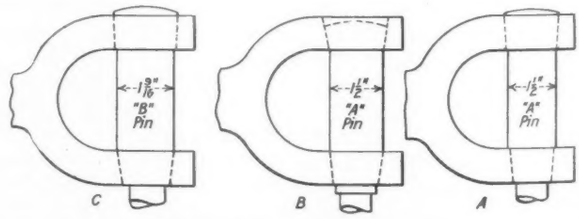


Fig. 3—Showing the Effect of Enlarged Taper Holes Due to Wear and Reaming

standard pins as shown at *B*, Fig. 3. To meet this condition and obtain a full taper surface on the small end of the pin, the diameter of the body must be made larger than standard as shown at *C*.

Satisfactory step sizes for the pin bodies are 1/16 and ⅛ in. larger than standard, as shown in Table 1, the relative diameters of taper ends *C* and *D*, and body *A* remaining

the same as shown in Fig. 2. Both the taper ends and body are thus enlarged 1/16 in. or ⅛ in.

Bushings should be standardized by making the bores a running fit on the pin bodies and the outsides sufficiently larger than standard to take care of enlarged lever holes. Table 2 shows the sizes for valve lever bushing suitable for use with the pins shown in Table 1.

The outside diameter of the first step size *A* is 1/16 in. larger than standard, the bore being of the standard diameter, suitable for use with pins *A*. In practice it has been found that the pins and bushings *A* are sufficiently larger than standard to take care of levers in which the taper holes in the jaws and the holes for bushings have been enlarged a moderate amount; i.e., approximately 1/16 in. as shown at *A*, Fig. 3. It is understood that either the pins or bushings may be ground down to a suitable size for holes in levers of any diameter between that required for new levers, or where enlarged to the amount mentioned.

Where the pins and bushings *A* are found too small owing to additional wear of lever holes, the pins and bushings *B* are used, these being 1/16 in. larger than *A* in bore and outside diameter. Again referring to Fig. 3, this condition is shown at *C*. The pins and bushings *C* are 1/16 in. larger than *B* and are used in badly worn levers.

When manufacturing bushings they should be of correct length, oil holes drilled, oil grooves milled, stamped with catalogue numbers, casehardened, bores ground to limits of plus or minus 0.001 in. and placed in stock.

Running Fits Between Pins and Bushings

Experience has shown that for a good running fit the bores of bushings after being forced into valve motion levers should be from 0.004 to 0.006 in. larger than the pin bodies. When pressing a bushing into a lever, the bushing bore compresses a certain amount as shown graphically at *B*, Fig. 4; also at times the levers are slightly out of round as shown at *C*. Under the latter conditions, owing to the thin bushing walls, the bushing assumes approximately the same shape as the hole in the lever. In order to take care of compression and imperfect holes, good practice has shown that the bores of bushings at the time of manufacture should be 0.008 in. larger than the diameter of the bearing surface of the pin.

As a general rule, it is advisable to make bushings to

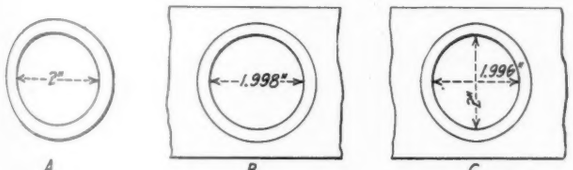


Fig. 4—Bushing Bore Reduced by Compression; Bushing Conforms to Hole in Lever

normal sizes, such as 1½ in., 2 in., etc. By this practice standard plug gages esaily obtainable from gage makers can be used. The body or bearing surface of pins are ground 0.008 in. smaller, or 1.492 in., 1.992 in., etc., the measurements being made with micrometer calipers to insure accuracy.

Manufacturing pins and bushings within the limits specified in Tables 1 and 2 does not call for more accurate workmanship than the everyday practice in manufacturing concerns, and this is a grade of workmanship which can readily be, and should be, the regular practice in railroad shops. However, proper facilities for measuring, such as micrometer calipers and plug gages must be provided, and the workmen should understand that the work must come up to the prescribed requirements.

Pins Made on Automatics

The pins are readily blanked out on automatic screw machines or turret lathes from bar stock. The taper ends, body and threaded end call for a grade of work easily obtainable when taking a single cut or pass with box tools, the principal requirement being to turn the body from 0.010 to 0.020 in. large to allow for final grinding. The spline, or hole for the key, and holes for cotter pins are readily drilled in a special jig which eliminates laying off, one adjustable drilling jig answering for all shapes and sizes. The holes for grinder centers in threaded ends are drilled when blanking out in the machines, the opposite or head ends being drilled in speed lathes.

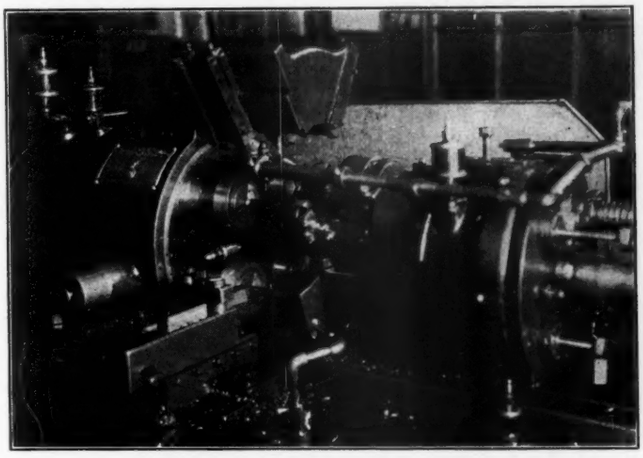


Fig. 5—Four-Spindle Automatic Adapted to Quantity Manufacture of Valve Motion Pins

With a modern six-spindle automatic screw machine these pins, 4¾ in. long, are blanked out, not including threading, at the rate of 14 an hour. This machine, however, can only be recommended for central shops or manufacturing concerns where the number of one design made at a time is in excess of 2,000 pins.

For the average shop, the four-spindle automatic screw machine (Fig. 5), or the single-spindle automatic, appears to meet the requirements best when considering the time taken to set up tools and adjust the camming. With the latter machines pins 4¾ in. long are readily blanked out and threaded at the rate of 5 an hour, or with a battery of four machines, one man can turn out 20 an hour, not including machine delays. When made on turret lathes, the output for the above-mentioned motion work pins is about 6 an hour on an average.

Casehardening

Preparatory to casehardening, the threaded ends of the pins are covered with fire clay, and gas pipe caps placed over the clay to hold the latter in place, thus preventing the threads from hardening. The pins are placed in casehardening boxes along with a suitable compound; sealed; the boxes placed in a furnace and allowed to remain about 10 hours or the amount of time necessary for the hardening to penetrate at least 1/16 in. To caseharden properly, the furnace is kept at a temperature of about 1,650 deg. F., as shown by pyrometers, the pyrometer being a part of the regular casehardening furnace equipment.

On removal from the furnace, the box is opened and the pins quenched directly from the casehardening heat. While this does not refine the metal as well as when allowing

the pins to cool off, be reheated and quenched, the results obtained by direct quenching meet all requirements.

Grinding Pin Bodies

The bodies of pins are now ground to sizes called for, keeping within the prescribed limits. Suitable machines for this purpose are the 10 in. by 24 in. or 10 in. by 36 in. plain cylindrical grinding machine. The grinding wheels should preferably be about ¼ in. wider than the body of the pin, for by this means the wheel can be fed directly onto the work without lateral motion.

Some makes of grinding machines are equipped with automatic in-feed and throw-out attachments, by which the wheel is fed onto the work automatically a predetermined amount without lateral motion of work or wheel. This is a desirable feature for railroad production work as it permits the operator to remove and place driving dogs on the pins while other pins are being ground.

The operation of grinding is as follows: After first truing the wheel with a diamond, a pin is placed in the machine and ground to the required size, the diameter being measured with micrometer calipers. The automatic throw-out for in-

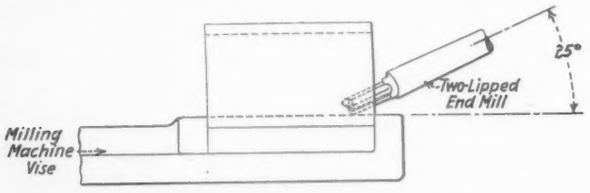


Fig. 6—Method of Milling Oil Grooves in Bushings

feed of the wheel is then set for the desired diameter. After this, while grinding one pin, the operator removes the dog from the pin previously ground, places it on another pin, oils the center holes, etc. When the body of the pin in the machine is ground to the correct diameter, the throw-out automatically stops the in-feed of the wheel. The wheel is then backed off and the pin removed. The new pin is placed in the machine, the wheel fed in by hand until just touching the work, when the feed is engaged which automatically feeds the wheel the required amount. The same cycle is gone through for each pin. As a check, each pin is measured with micrometers when removed from the machine.

By this process, the grinding is almost continuous. With proper grinding wheels, the wheel wear is slight, but as each pin is measured, the throw-out for in-feed is reset to compensate for wear.

A good operator can grind from 20 to 30 pin bodies per hour, the ground surfaces being far superior to those obtained by filing.

Manufacturing Bushings

Bushings are preferably manufactured on single spindle automatic screw machines or turret lathes from bar stock or seamless steel tubing. When made from bar stock, the bar is drilled and rough turned at the same time; then finish turned and reamed; then cut off. The reaming is about 0.010 in. smaller than the size called for which allows for the final internal grinding. When made from seamless tubing having the correct external and inside diameters, the operations are reduced to that of cutting off. However, the internal diameter must be about 0.010 in. below standard to allow for final internal grinding, the same as with bushings made from bar stock. The question of using bar stock or tubing is determined by relative costs considering the price of material, labor and overhead.

After completing in the above machines, catalogue numbers are stamped on bushings; oil holes drilled using the drilling jig; and oil grooves milled as shown in Fig. 6. The milling cutter best adapted for the last operation is a two-lipped end mill about 5/16 in. in diameter. This cutter is used in a vertical milling attachment on a horizontal knee-type milling machine, the cutter being set to an angle about 30 deg. from the horizontal. When milling, the bushing is held on its two ends in a milling machine vise. The milling operation is as follows. The bushing is placed in the vise; the table raised until the mill sinks into the bushing the required depth at one end (the height of the table being governed by stops or a dial gage on the machine); the table is then fed the required amount to mill the oil groove; the table is lowered and the bushing removed. This results in a superior oil groove which only takes a fraction of the time required when forming with a hammer and chisel. The oil grooves are milled at the rate of 30 to 50 an hour.

The bushings are next casehardened and the bores quickly ground on internal grinding machines such as shown in Fig. 7. The principal requirements for this work are a rugged machine, quick means for holding bushings, and ability to caliper or gage the bore in the minimum amount of time. In other words, the speed of internal grinding is largely a question of the time consumed in chucking, stopping, starting and gaging.

With the chucking grinder (Fig. 7) the valve motion bushing is held in a 3-jaw universal chuck. The grinding wheel spindle is moved up to and away from the work by the large hand wheel. The operation of this hand wheel to the right also brings the universal chuck to rest, when, owing to the grinding wheel being so far removed, the work is readily gaged. By moving the handle wheel to the left, the chuck spindle is set in motion. The longitudinal feed for moving the grinding wheel back and forth in the bushing is thrown in. As a result of these little-time-savers, the grinding is almost continuous which increases the output to an extent where internal grinding is not an expensive operation.

In this work it is customary to make use of plug gages for sizing holes, the operation when grinding being to set the in-feed stop of the machine after grinding the first bushing to

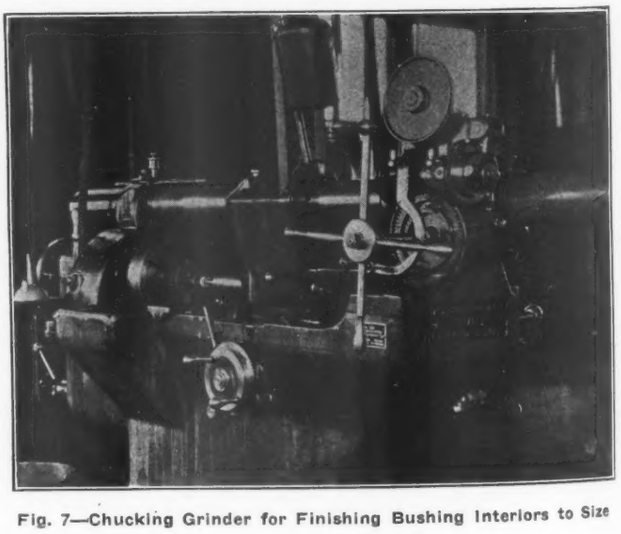


Fig. 7—Chucking Grinder for Finishing Bushing Interiors to Size

the correct size. After this the bushings are ground until the correct size is indicated by the feed stop. The hand wheel is then moved to the right and the bushing tested with a plug gage. If of the proper diameter, it is removed; if too small, the grinding is continued and the feed stop reset to compensate for grinding wheel wear.

Fitting Pins to Valve Motion Levers

When levers are received in the repair shop, the taper holes are re-reamed either in a drill press or by hand just enough to remove rough spots and true the holes, care being

taken not to enlarge the holes more than is absolutely necessary. When reamed in a drill press, floating holders or drive are employed to insure the most accurate reaming. The holes will of course vary in diameter and it is therefore necessary to fit each pin individually which is done quickly when the shop is properly equipped for this work.

After reaming and before fitting pins, it is necessary to measure the diameter of taper holes in clevises which is a slow operation without suitable gages. One of the most handy gages for this purpose is shown in Fig. 8 and its

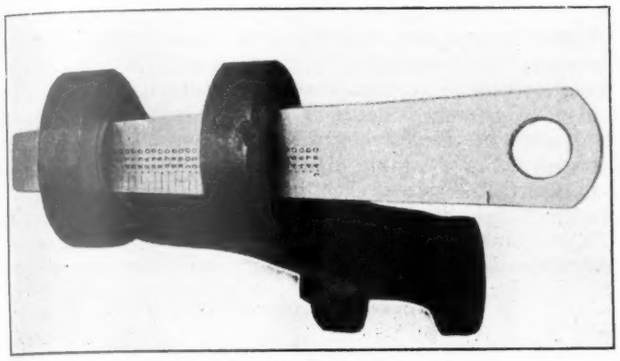


Fig. 8—Gage for Measuring Taper Holes and Checking Their Accuracy

method of use in Fig. 1. This gage is about ¼ in. thick, made as follows: The two ends are centered; the edges rough ground to an approximate size and taper while revolving on the grinder centers. The gage is hardened; finish ground to standard taper; diameters stamped on the surface; and finally lines agreeing with the diameters are etched on one face so this side resembles a rule or scale. When etching, the gage is covered with wax, placed in a milling machine and graduated as follows: A point is carefully measured on the taper surface of the gage agreeing in diameter with a number or stamped size. A line is drawn at that point and the remaining lines are then drawn in the wax by a scratch point held in the machine spindle, the correct distances between graduations being indicated by a micrometer dial on the table lead screw. A line is generally placed on the gage to show the maximum size of re-reaming allowable which is a check against too great enlargement of holes. A convenient graduation for 1 in. taper per foot is to space the lines 0.120 in. apart, each line showing an increase in diameter of 0.010 in.

Measuring Taper Holes in Levers

The flat gage is used both for checking the accuracy of reaming and sizing taper holes. For checking the accuracy of taper reaming, the gage is placed in a hole (Fig. 1), given about ⅛ in. turn which centers it in the hole, and tried for rocking or side motion at both ends. If there is an absence of side motion at both ends, the hole has been properly reamed. If there be side motion, it is an indication of improper reaming which at once calls attention to defective reamers or bad work when reaming.

Making use of gages of this kind in railway shops has a wonderful effect on the accuracy of reaming, which in turn tones up the general grade of work. Owing to the small amount of time taken to test the accuracy of a hole, practically all holes will be tested and should there be errors, the foreman will be in a position to fix the blame either on the reamer or workman who does the reaming. In other words, a check is available that can be made use of without elaborate preparations.

Grinding Taper Ends of Pins

Experience has shown conclusively that the taper ends of valve motion pins can be ground much quicker than by the past practice of turning and filing. Casehardened or soft pins are ground in practically the same time.

With hardened pins the grinding will at times cut below the hardened surfaces, but, as the two taper ends are a tight fit and not a running fit in levers, it is of but little moment if these surfaces are hard or soft. The principal requirement, as well understood, is to obtain a hard surface on the journal or body such as is insured with the processes of manufacture already explained.

The number of pins ground in a given time to fit rod jaws is in reality governed more by the appliances available and the way of going about the job than by the time the grinding wheel is actually cutting. In other words, it is the time between grindings that adds up and not so much the actual grinding. It therefore follows that any device which will reduce the time of handling should be utilized. Several devices for this purpose are explained below.

Driving dogs are used which screw on to the threaded ends of the pins as shown at *D*, Fig. 9. These dogs revolve free of the grinding centers, thus allowing the pins to turn on their own centers. The driving arm of the dogs is located at the side nearest the grinder headstock in order to prevent coming in contact with the wheel when grinding the smaller ends of pins. Driving dogs are applied or removed without the use of a wrench which is a small point but saves the operator picking up a wrench each time a pin is finished.

When preparing to grind taper ends, the grinding machine table (Fig. 9) is swivelled and set as near as possible to the required taper per foot from graduations marked on the end of the table. The grinding wheel is trued with a diamond and a pin placed in the machine. In order to prove the correctness of the angle to which the table is set, it is customary

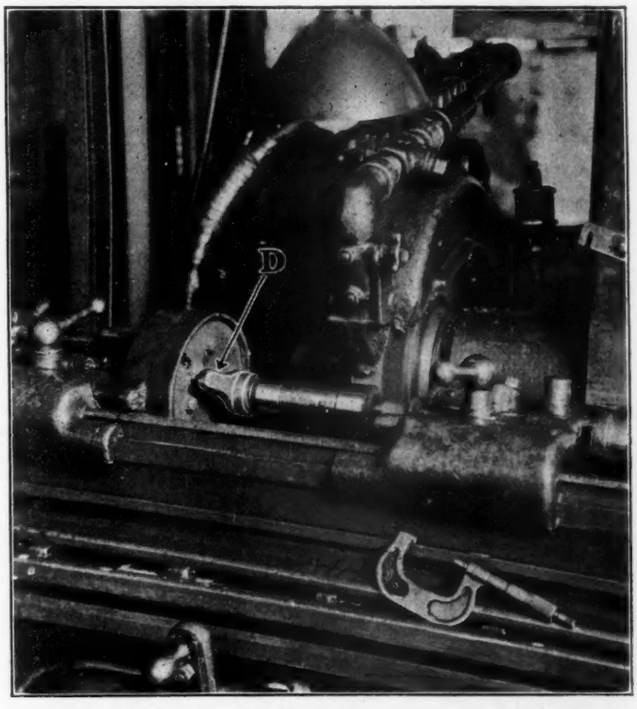


Fig. 9—Close-up View Showing How Taper End Bearings Are Ground

to grind the first pin a trifle larger than required and try it in the taper hole of the lever. The table is then given such final adjustments as may be necessary to insure a perfect fit of the pin. After properly setting the angle of the table, a large number of pins are ground without other adjustments.

The taper ends are ground by feeding the grinding wheel directly on the work without lateral motion. The grind-

ing and sizing operations are as follows: The smaller of the two ends is first ground, being measured with micrometer calipers, until the diameter nearest the body is the same as readings taken from the taper gage. When this end has been ground to the correct size, the throw-out stop for in-feed of the grinding machine is set to zero; the grinding wheel is backed off and transferred to the large end. The large end is then ground by feeding the wheel in to the same setting of the throw-out stop which results in finishing the large end to the same taper as the small end. The operator judges the the time when the grinding wheel should be stopped largely by the sparks thrown off.

Output of Fitted Pins per Hour

A skillful operator can grind the taper ends of practically all pins to fit the levers on the first trial. Assuming that the levers are located close to the machine, the output, including handling levers, measuring with a taper gage, grinding, and driving the pins into place, is from 6 to 10 pins an hour, or sufficient to meet the average requirements of a shop repairing 75 locomotives a month.

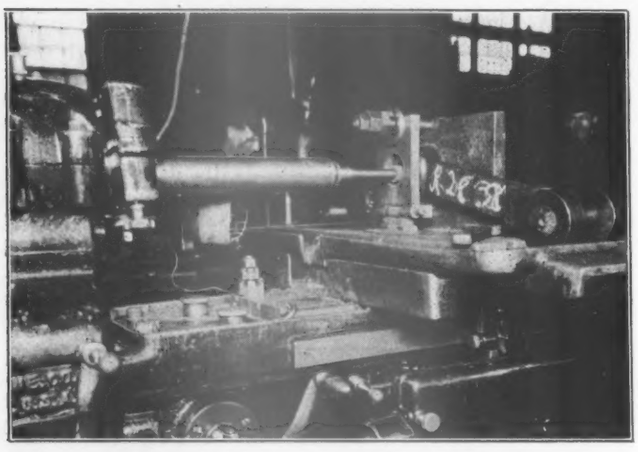


Fig. 10—Truing Worn Bushing Hole in Valve Motion Lever

Among the advantages gained by grinding may be mentioned the more accurate fitting owing to smooth surfaces; casehardened pins are finished as readily as soft; stock pins, economically manufactured by quantity production, can be used. From a repair shop operating standpoint, having these pins semi-finished and the bodies ground to sizes to fit the bushings is a decided advantage compared with older methods of making each piece individually, drilling cotter pin holes and where hardened pins are used, waiting for casehardening.

Fitting Bushings to Levers

In order to correct the defect, shown graphically at *C*, Fig. 4, it has been found good practice to true the holes in levers before applying bushings. In repair work practically every lever hole is of a different diameter and to attempt to ream the holes would require a large number of reamers. The time required for reboring is prohibitive. Either method results in an excessive enlargement of holes which shortens the useful life of levers. Practice has shown that the holes are trued quickly and accurately by grinding on planetary internal machines, such as shown in Fig. 10.

The operation of grinding a link foot hole, well shown by the illustration, is as follows: The link or lever is bolted to an angle plate, on the grinder table. (For long levers or rods, such as the radius and eccentric rod, the outer ends are supported by chains attached to a jib crane.) The table is adjusted vertically and horizontally so that the planetary movement of the spindle causes the wheel to grind an equal amount on all sides of the hole. The dogs controlling the longitudinal travel of the table are set and, if necessary, the wheel is trued with a diamond. During the grinding, the table and work automatically travel longitudinally, the wheel spindle eccentricity being gradually enlarged by hand as the hole is enlarged. This is continued until high spots or irregularities are removed, resulting in a true hole, enlarged only the minimum amount.

As a general rule, it is advisable to grind holes for bushings in valve motion levers when they differ more than 0.003 in. from a true cylinder. This must be understood to mean the amount the hole is out of round and not the actual diameter of the hole. Owing to the quick method of fitting bushings next explained, the diameter of holes in levers from a repair shop standpoint is not important.

Under conditions met with in repair work, practically no two holes in valve motion levers into which bushings are pressed are of the same diameter which makes it necessary to finish the outside of each bushing to a different diameter. In practice, either hard or soft bushings, such as shown in Table 2, are quickly ground on the outside to meet this condition of varying sized lever holes.

Calipering Hole Diameters

For calipering the diameters of holes in levers, a sliding triangular gage is used similar to the one described in detail on page 711 of the December, 1922, *Railway Mechanical Engineer*. In using this gage it is tried at several angles for the purpose of detecting errors in roundness, the latter being indicated to a person accustomed to its use by the rocking motion or "feel" in different positions. When there is a question as to the necessity of grinding a hole, the diameter is measured at the larger and smaller diameters and should this variation exceed 0.003 in., the lever is sent to a planetary grinder for truing defective holes. In the event of the hole being satisfactory, its diameter is ascertained by measuring over the projecting end of the gage with micrometer calipers, a person accustomed to this work measuring a hole in less than ½ min. This gage has the advantages of speed, accuracy and the use of one micrometer for measuring both the diameter of the hole and outside of the bushing.

Bushings, as shown in Table 2, are finished complete, including grinding the bores at the time of quantity manufacture. Therefore, all that remains to be done is to finish the outsides to a size suitable for a force fit in the levers. This is economically done on 10-in. by 36-in. plain cylindrical grinders.

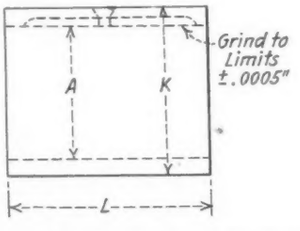


Table 2—Proposed Step Sizes for Valve Motion Bushings

Step sizes	A	K	L
Standard	1½ in.	1⅞ in.	2¼ in.
A	1½ in.	2 in.	2¼ in.
B	1⅝ in.	2⅛ in.	2¼ in.
C	1⅝ in.	2⅛ in.	2¼ in.

When fitting a bushing, the diameter of the hole in the lever is measured with the triangular gage and micrometer, a suitable bushing for the class being selected from stock and placed on an expanding arbor in the grinder. The diameter is then ground from 0.003 to 0.004 in. larger than the lever hole, the diameter of the bushing being measured

with the same pair of micrometers used on the triangular gage. For short bushings it is the practice to feed the grinding wheel directly on to the work; for bushings where the length is greater than the wheel width, traversing motion is used.

Assuming that the levers are located close to the machine, thus avoiding the necessity of the operator traveling long distances when obtaining measurements, from 8 to 10 bushings are ground in an hour, including the measurement of lever holes.

As previously mentioned, the bores of *A* bushings (Table 2) and *A* pins (Table 1) for the same class of locomotive and part are ground to the proper diameter for a running fit on each other. When the lever holes have not been enlarged to any great extent, both *A* bushings and pins are used. As a result, the companion parts, such as lap and lead lever and lap and lead lever connector to crosshead, are bushed or pins applied without pairing these two levers. This makes it possible to repair the entire lot of each kind of levers that may be in the shop and then repair another lot of different levers. All lap and lead levers available are bushed or pins fitted at one time. The same operation is gone through with for the links, the radius rods, the eccentric rods, etc. After applying, bushings and pins, the levers are placed on racks and used as the erecting shop needs them.

Where lever holes are badly worn, *B* pins and bushings are used. These are similar to *A* pins and bushings and pair with each other, but cannot be used with the latter. In case of excessive wear, class *C* pins and bushings are used which will not pair with class *A*, or *B*. Where conditions require large pins or bushings, the companion levers must be kept in pairs. Experience indicates that 90 per cent of all repairs can be made with class *A* pins and bushings.

Summary of Advantages

The advantages gained by standardizing are: First, quantity production at reduced cost, eliminating the work of fitting each individual pin to each bushing at the time of making repairs. From a repair shop standpoint, another great advantage is owing to the fact that the levers can be used on any locomotive of the same class; they need not be put back on the same locomotive and any lever for the same class of locomotive will pair up with its companion lever. Finally, the quality of the fitting and bearing surfaces is greatly improved, tending to increase the time between repairs and the effective life of motion levers and parts.

Fuel Consumption of Oil Burning Locomotives*

Data Obtained on Southern Pacific Facilitate Comparison of Steam and Electric Motive Power

By A. H. Babcock
Electrical Engineer, Southern Pacific Railroad

PART II

IT will be of interest to follow a train from Kern Junction to Summit. All freight trains stop at Kern Junction to check the register, and for orders. The grade from Kern Junction to Magunden being light, the acceleration is high, and the speed at Magunden averaged about 38 miles per hour. According to the curve the fuel consumption per 1,000 ton-miles on a 0.1 per cent grade at constant speed would be 10.25 gallons. The actual fuel consumption as shown by "A" is 16.29 gallons. The difference (16.29 — 10.25 = 6.04) represents the fuel cost of acceleration. The grade from Magunden to Edison is 0.83 per cent. The speed of the train was reduced from about 38 miles to 30 miles per hour. According to the curve the fuel consumption should be 20.75 gallons, but the actual fuel consumption is 16.43 gallons. The difference (20.75 — 16.43 = 4.32) represents the fuel saved by using a part of the kinetic energy in the train. From Edison to Flag No. 1 the grade is increased to 1.16 per cent, the speed of the train is reduced to about 26 miles per hour, and point "C" is at the left of the curve. From Flag No. 1 to Flag No. 2 the grade is—1.22 per cent, the speed of the train is increased to 38 miles per hour, the kinetic energy is increased, and point "D" is at the right of the curve. From Flag No. 2 to Flag No. 3 the grade is 0.89 per cent, the speed is reduced to 31 miles per hour, and point "E" is at the left of the curve. From Flag No. 3 to Flag No. 4 the grade is 2.21 per cent, the speed is reduced to 17 miles per hour, and point "F" is at the left of the curve. From Flag No. 4 to Flag No. 5 the grade is 1.14 per cent, the speed is increased to 20 miles per hour, and point "G" is at the right of the curve. From Flag No. 5 to Flag No. 6 the grade is 2.31 per cent, the distance is over 23 miles, the drop in speed from 20 to 12 miles per hour has very little effect on the total fuel burned, and point "H" is on the curve. From Flag No. 6 to Tehachapi, the grade is 1.24 per cent, and although the train accelerated after passing Flag No. 6, which would tend to increase the fuel consumption, the train was brought to rest at Tehachapi and the kinetic energy in the train offset a part of the fuel that would have been burned at constant speed, and point "I" falls to the left of the curve. From Tehachapi to Summit the grade is 0.62 per cent. The train started from rest, therefore due to acceleration point "J" falls to the right of the curve. It is of interest to note that the actual test data illustrate the well known fact that kinetic energy can be exchanged for fuel and fuel for kinetic energy.

It is not considered that the results of this test should be depended upon for slight grades either positive or negative, because there is no section of level track between Bakersfield and Mojave. For grades of less than 0.5 per cent, both positive and negative, the curve should not be depended upon for accurate results.

A locomotive of lower thermal efficiency than the No. 3614 would burn more fuel for any given grade than that shown on the curve. The result would be a flatter curve. On the other hand a locomotive of higher thermal efficiency would burn less fuel than shown and the curve would be steeper. It is, therefore, apparent that the slope of the curve is a func-

*A paper presented at the spring convention of the American Institute of Electrical Engineers at Pittsburgh, Pa., on April 25. This is the second part of an article in two parts. The first part described a method employed for securing an accurate measurement of the efficiency of an oil-burning steam locomotive in moving a 1,000-ton train over a given piece of track. The following describes the manner in which the method was applied and includes the results obtained.

tion of the efficiency, and the steeper the curve the higher the efficiency.

Fuel Required

From the curve, the fuel required per 1,000 ton-miles on a 2 per cent grade equals 38.0 gallons, and for a 1 per cent grade equals 23.3 gallons. The difference (38.0 — 23.3 = 14.7) represents the fuel burned moving a 1,000 ton train one mile over a 1 per cent grade without friction; because both the 38.0 and the 23.3 gallons are for grade resistance plus train friction, the train friction being the same in each case, the difference is for a differential grade resistance of 1 per cent. A 1 per cent grade resistance is 20 pounds per ton. Then the work done in moving the given train one mile over a 1 per cent grade without friction equals $20 \times 1{,}000 \times 5{,}280 = 105{,}600{,}000$ foot pounds. This required 14.7 gallons of fuel or $14.7 \times 8 \times 18{,}000 \times 778.1 = 1{,}647{,}082{,}080$ foot pounds. The thermal efficiency equals $105{,}600{,}000/1{,}647{,}082{,}080 = 0.0641$, or 6.41 per cent. It will be seen at once that this method of determining engine thermal efficiency is independent of train resistance at driver tires which, at the best, is a difficult matter to determine with accuracy.

The method used above for determining efficiency is based on a known weight of train, a known grade resistance and test values for fuel consumption, and should be very nearly correct.

The fuel burned on a 1 per cent grade for grade and train resistance is 23.3 gallons. If the train resistance equals X then:

$$(20 + X)/X = 23.3/(23.3 - 14.7)$$

From which X equals 11.7 pounds per ton.

This does not check with the assumed 7 pounds per ton, shown in Table V, because the 7 pounds covers only rolling friction, and the 11.7 pounds is for rolling friction plus locomotive internal friction, such as pistons, valves, and other engine parts. If Schmidt's 7 pounds is correct for the rolling friction then the difference, (11.7 — 7), 4.7, is the locomotive internal friction; this friction for the given train of 1,000 tons is equal to a drawbar pull of $4.7 \times 1{,}000 = 4{,}700$ pounds, or about 9.0 per cent of the total drawbar pull on the maximum grade of 2.31 per cent from Flag No. 5 to Flag No. 6.

As the negative grade increases, the fuel consumption is reduced until the negative grade resistance is numerically equal to the total frictional resistance of train and engine. The minimum fuel consumption of 2.5 gallons per mile as shown on the curve represents standby losses and should be about equal to the fuel burned standing on a siding with the train, which is 42.8 gallons per hour. Then $42.8/2.5 = 17.1$ is the drifting speed of the train in miles per hour, that corresponds to the minimum consumption of fuel. The down grade speed limit for freight trains by order is 18 miles per hour. Evidently, then, there is a good compliance with orders. For heavy negative grades the fuel consumption is again increased, for pumping air for braking purposes.

The over-all efficiency determined by this test was 5.57 per cent. It is the ratio of the integrated foot pounds of work done by the engine whenever the drawbar pull was positive, to the total energy in the fuel used over the same time. Apparently it is constant for all grades greater than 0.5 per cent.

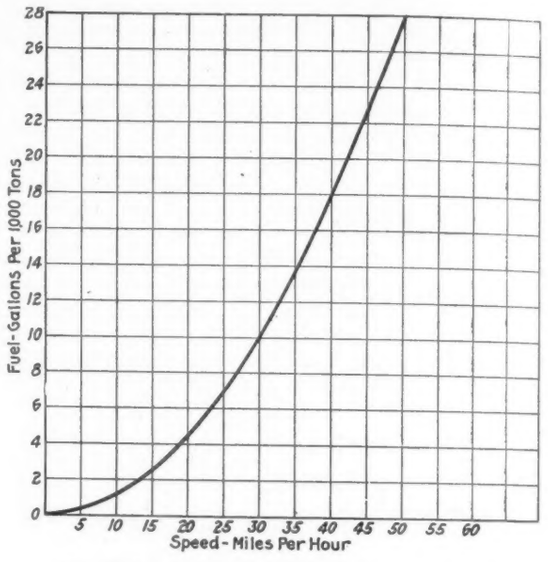


Fig. 6—Fuel Required to Accelerate 1000 Tons
Over-all thermal efficiency = 5.65 per cent

For a long time it has been known that drifting as much as possible saves fuel. Except on positive grades only, seldom is it possible to drift to rest. Fig. 6 gives a measure of the saving that may be made by taking advantage of favorable opportunities. The kinetic energy, in terms of fuel, in a 1,000 ton train moving at 50 miles per hour equals 27.74 gallons. If the engineer makes a sudden stop by heavy braking the greater part of this 27.74 gallons is lost in heat at the brake shoes. If his train schedule will permit him to drift down to 25 miles per hour before applying brakes the fuel equivalent for kinetic energy is 6.93 gallons, and 20.81 gallons of fuel will be saved. The curve shows that drifting to one-half of the normal running speed before applying brakes saves 75 per cent of the fuel equivalent for kinetic energy.

There has been much discussion of the question which train should take siding, when trains meet on a single-track line, that the maximum fuel economy should result. Many elements, other than fuel, enter into the total cost. The fuel burned chargeable to the meet is for two purposes: First for slowing down or stopping to throw switches, and second, for

TABLE III—GRADE AND CURVATURE—TEHACHAPI—EASTBOUND

Location From	Location To	Distance miles	Rise feet	Total curvature degrees	Average grade per cent	Average curvature degrees	Per cent grade correction for curvature*	Equivalent grade per cent
Kern Jct.	Magunden	3.4	17.8	.....	0.10	....	....	0.10
Magunden	Edison	3.1	135.7	.....	0.83	....	....	0.83
Edison	Flag 1	5.62	342.9	17.5	1.16	0.06	....	1.16
Flag 1	Flag 2	1.004	—68.9	99.3	—1.30	1.9	0.08	—1.22
Flag 2	Flag 3	6.225	268.9	589.5	0.82	1.8	0.07	0.89
Flag 3	Flag 4	0.892	89.0	376.3	1.89	8.0	0.32	2.21
Flag 4	Flag 5	2.179	115.0	417.5	1.00	3.6	0.14	1.14
Flag 5	Flag 6	23.355	2,575.0	6,751.0	2.09	5.48	0.22	2.31
Flag 6	Tehachapi	1.225	79.5	17.6	1.23	0.3	0.01	1.24
Tehachapi	Summit	1.8	58.5	.....	0.62	....	....	0.62
Summit	Flag 7	2.078	—46.0	.....	—0.42	....	....	—0.42
Flag 7	Flag 8	1.136	—65.0	13.6	—1.08	0.2	0.01	—1.07
Flag 8	Proctor	1.486	5.5	46.4	0.07	0.6	0.02	0.09
Proctor	Flag 9	1.488	—39.5	.....	—0.50	....	....	—0.50
Flag 9	Flag 10	0.852	—80.0	98.3	—1.78	2.2	0.09	—1.69
Flag 10	Flag 11	1.914	—50.0	27.9	—0.50	0.3	0.01	—0.49
Flag 11	Flag 12	8.637	—960.00	547.7	—2.10	1.2	0.05	—2.05

standby while waiting for the other train. The standby losses depend upon time rather than tonnage and have been discussed previously in the second group of factors.

As long as every movement of the train is in the normal direction that the train is traveling, only the extra fuel required for slow-downs or stops should be charged against the meet. Table V gives gallons of fuel burned running through sidings, distance in feet through sidings, weight of train, gallons of fuel that would have been burned moving the same distance on the main line, and the extra fuel burned.

TABLE IV—FUEL PER 1,000 TON-MILES—TEHACHAPI

Section		Gallons of fuel per 1,000 ton-miles	
		Eastbound	Westbound
Kern Jct.	Magunden	16.29	6.31
Magunden	Edison	16.43	2.93
Edison	Flag 1	20.86	3.13
Flag 1	Flag 2	6.11	21.03
Flag 2	Flag 3	16.31	3.50
Flag 3	Flag 4	30.71	2.24
Flag 4	Flag 5	26.39	3.35
Flag 5	Flag 6	42.43	2.77
Flag 6	Tehachapi	23.17	4.71
Tehachapi	Summit	20.59	4.24
Summit	Flag 7	5.62	15.19
Flag 7	Flag 8	1.62	15.33
Flag 8	Proctor	6.73	11.27
Proctor	Flag 9	4.35	22.14
Flag 9	Flag 10	2.70	27.17
Flag 10	Flag 11	4.30	19.82
Flag 11	Flag 12	3.06	46.56

An analysis of results indicates that taking siding on a heavy grade was quite different from taking siding on a medium grade. The first group in Table No. V is for grades over 2 per cent, and the second group for grades less than 2 per cent. The average fuel cost of taking siding on grades of over 2 per cent is 18.3 gallons. For grades materially less than 2 per cent no extra fuel was burned. The trains do not move at a speed of over 12 miles per hour up heavy grades, so that the fuel required for acceleration is less than 2 gallons per 1,000 ton train. Brakes are applied to hold

TABLE V—FUEL COST OF MEET PER 1,000 TON TRAIN—TEHACHAPI

Trip	Fuel burned through siding gallons	Distance through siding feet	Weight of train tons	Fuel per 1,000 tons gallons	Fuel for equivalent distance main line gallons	Fuel cost of meet gallons	Station
Grades Over 2 Per Cent							
2—E	44	4,374	1,030	42.7	34.0	8.7	Allard
6—E	70	4,544	1,018	68.8	35.2	33.6	Woodford
7—E	45	4,544	1,001	45.0	35.2	9.8	Woodford
8—E	45	4,544	1,021	44.0	35.2	8.8	Woodford
9—E	51	4,544	1,018	50.2	35.2	15.0	Woodford
1—W	89	5,468	1,020	87.2	42.4	44.8	Rowen
2—W	45	4,291	1,019	44.2	33.4	10.8	Cable
3—W	40	4,013	1,067	37.5	31.1	6.4	Warren
7—W	65	4,287	1,089	59.7	33.2	26.5	Fram
Totals			9,283			164.4	
Average			1,031			18.3	per 1,000 ton train.
Light Grades							
1—E	25	4,411	1,021	24.5	20.0	4.5	Bena
5—E	18	4,305	1,016	17.7	26.1	6.4	Ilmon
4—E	21	4,411	1,020	20.6	20.0	0.6	Bena
5—W	22	5,315	1,064	20.6	22.2	—1.6	Cameron
Total						—2.9	
Average						—0.7	

the train rather than to stop the train. It is believed therefore that the extra fuel burned taking siding on heavy grades is due to the fact that the slow, heavy starting and pulling works the engine beyond its most efficient point, and in several cases the locomotive slipped its wheels. On light grades a freight train moves at a speed of 20 to 35 miles per hour. But trains take siding at low speed on all grades. The drawbar pull per ton is greater at high speed than at low speed, and the fuel saved by moving through sidings at a low and more efficient speed offsets the fuel loss due to braking. It is felt that these results should be applied in general with caution, because fuel used varied between wide limits.

The engineer is held responsible for the fuel charged to road service. Part of this fuel is burned in the actual progression of the train; the remainder is burned in locomotive or train movements incident thereto. The fuel burned in actual train movements depends upon the efficiency of the locomotive and the skill of the engineer. The fuel burned for miscellaneous purposes depends upon traffic conditions and the general efficiency of the division organization in handling traffic. In this discussion the ratio between the fuel burned moving the train and the total fuel charged to road service is called "Operating Efficiency, Fuel." The operating efficiencies for each trip, averages eastbound and westbound, and for all test trips, are shown in Table VI.

TABLE VI—OPERATING EFFICIENCY—FUEL—TEHACHAPI

Ratio between fuel burned moving train and total fuel burned from 30 minutes before leaving initial terminal until 10 minutes after arrival at home terminal.

Trip	Operating efficiency per cent
1—E	92.6
2—E	96.1
3—E	96.5
4—E	93.9
6—E	89.5
7—E	95.1
8—E	95.7
9—E	95.2
Average eastbound	94.3
1—W	88.3
3—W	90.7
4—W	87.1
5—W	87.7
6—W	93.0
7—W	89.6
8—W	85.1
Average westbound	88.7
Weighted average eastbound and westbound	92.5

TABLE VII—LOCOMOTIVE THERMAL EFFICIENCY—TEHACHAPI

For a Train of 1,000 Tons—Eastbound

Location		Distance		Equivalent grade per cent	Grade resistance lb./ton	Total resistance lb./ton
From	To	Miles A	Feet B	C	D C × 20	E D + 7
Firing up 90 min.		.....	.....	.....	.....	.....
Standby 60 min.		.....	.....	.....	.....	.....
Testing air 30 min.		.....	.....	.....	.....	.....
Bakersfield	Kern Jct.	0.7	3,700	0.07	1.4	8.4
Kern Jct.	Magunden	3.4	17,950	0.1	2.0	9.0
Magunden	Edison	3.1	16,370	0.83	16.6	23.6
Edison	Flag 1	5.62	29,670	1.16	23.2	30.2
Flag 1	Flag 2	1.004	5,300	—1.22	—24.4	—17.4
Flag 2	Flag 3	6.225	32,860	0.89	17.8	24.8
Flag 3	Flag 4	0.892	4,710	2.21	44.2	51.2
Flag 4	Flag 5	2.179	11,500	1.14	22.8	29.8
Flag 5	Flag 6	23.355	123,300	2.31	46.2	53.2
Flag 6	Tehachapi	1.225	6,470	1.24	24.8	31.8
Tehachapi	Summit	1.8	9,500	0.62	12.4	19.4
Summit	Flag 7	2.078	10,970	—0.42	—8.4	—1.4
Flag 7	Flag 8	1.136	6,000	—1.07	—21.4	—14.4
Flag 8	Proctor	1.486	7,850	0.09	1.8	8.8
Proctor	Flag 9	1.488	7,860	—0.50	—10.0	—3.0
Flag 9	Flag 10	0.852	4,500	—1.69	—33.8	—26.8
Flag 10	Flag 11	1.914	10,100	—0.49	—9.8	—2.8
Flag 11	Flag 12	8.637	45,600	—2.05	—41.0	—34.0
Flag 12	Mojave	0.709	3,740	—1.15	—23.0	—16.0
Mojave to engine-house 60 min		.....	.....	.....	.....	.....
Standing at stations 80 min.		.....	.....	.....	.....	.....

Such a ratio is a measure of the operating efficiency of the division organization. The high value determined by this test, 92.5 per cent, indicates a co-operation between dispatchers and train crews not often realized. It indicates also a very small margin of possible gain between steam locomotives, well handled, and the theoretical limit of the electric locomotive, 100 per cent less engine auxiliaries. A second track would undoubtedly raise this ratio; but single-track operation does not excuse a low efficiency.

Many changes have been made in locomotive design during the past few years. Larger units, higher boiler pressure, superheaters, and, more recently, the addition of feed water heaters and boosters, have gone a long way toward increasing efficiency. Though the locomotive used for this test is one of the well-known types for heavy mountain service, and was tested under its most economical load, yet the average thermal

efficiency is less than 6 per cent; hence a slight numerical increase in this efficiency would result in a tremendous saving in fuel. For example, the Super Power Survey showed an expected fuel saving of 67 per cent in freight service, which means a thermal efficiency of about 8.5 per cent. Whether in electric service such a point is within reach, others must determine. In making such comparisons it is necessary

TABLE VII—PART 2

Eastbound

Distance miles A	Total weight of train tons F	Total tractive effort pounds G E × F	Million ft. lb. at drivers constant speed H B × G/10⁶	Hp. hr. at drivers constant speed I H/1.98	Thermal hp. hr. for 5.57 per cent efficiency J + only I/0.0557	Computed fuel gallons K J/0.01765
....	.....	.....	.....	.....	.....	90.0
....	.....	.....	.....	.....	.....	20.0
....	.....	.....	.....	.....	.....	21.0
0.7	1,000	8,400	31.1	15.7	281.8	4.9
3.4	1,000	9,000	161.6	81.6	1,464.0	25.5
3.1	1,000	23,600	386.3	195.1	3,502.0	60.9
5.62	1,000	30,200	896.0	452.6	8,121.0	141.4
1.004	1,000	—17,400	—92.2	—46.6	.....	6.0
6.225	1,000	24,800	815.0	411.7	7,390.0	128.6
0.892	1,000	51,200	281.2	121.8	2,186.0	38.1
2.179	1,000	29,800	342.7	173.1	3,106.5	54.1
23.355	1,000	53,200	6,559.0	3,312.0	59,455.0	1,034.7
1.225	1,000	31,800	205.3	103.9	1,865.0	32.5
1.8	1,000	19,400	184.3	93.1	1,671.0	29.1
2.078	1,000	—1,400	—15.4	—7.8	.....	11.0
1.136	1,000	—14,400	—86.4	—43.6	.....	2.5
1.486	1,000	8,800	69.1	34.9	626.3	10.9
1.488	1,000	—3,600	—23.6	—11.9	.....	7.0
0.852	1,000	—26,800	—120.6	—60.9	.....	2.5
1.914	1,000	—2,800	—28.3	—14.3	.....	8.5
8.637	1,000	—34,000	—1,551.0	—783.0	.....	29.7
0.709	1,000	—16,000	—59.8	—30.2	.....	4.7
....	.....	.....	.....	.....	.....	20.0
....	.....	.....	.....	.....	.....	57.0
						1,840.6

to take account of the ratio, revenue freight weight to total train weight. In this study it was 0.743. In electric service it may be very different. The mechanical engineers of this country will hardly admit that they are satisfied with even the best engine yet designed. The efficiency determined during this test is lower than many published values, but, as a rule,

TABLE VII—PART 3—LOCOMOTIVE THERMAL EFFICIENCY—TEHACHAPI

For a Train of 1,000 Tons—Westbound

Location From	Location To	Distance Miles A	Distance Feet B	Equivalent grade per cent C	Grade resistance lb./ton D C × 20	Total resistance lb./ton E D + 7
Firing up 60 min.	.....	.....	.....	.....	.....	.....
Standby 30 min.	.....	.....	.....	.....	.....	.....
Testing air 30 min.	.....	.....	.....	.....	.....	.....
Mojave	Flag 12	0.709	3,740	1.15	23.0	30.0
Flag 12	Flag 11	8.637	45,600	2.15	43.0	50.0
Flag 11	Flag 10	1.914	10,100	0.51	10.2	17.2
Flag 10	Flag 9	0.852	4,500	1.87	37.4	44.4
Flag 9	Proctor	1.488	7,860	0.50	10.0	17.0
Proctor	Flag 8	1.486	7,850	—0.05	—1.0	6.0
Flag 8	Flag 7	1.136	6,000	1.09	21.8	28.8
Flag 7	Summit	2.078	10,970	0.42	8.4	15.4
Summit	Tehachapi	1.8	9,500	—0.62	—12.4	—5.4
Tehachapi	Flag 6	1.225	6,470	—1.22	—24.4	—17.4
Flag 6	Flag 5	23.355	123,300	—1.87	—37.4	—30.4
Flag 5	Flag 4	2.179	11,500	—0.86	—17.2	—10.2
Flag 4	Flag 3	0.892	4,710	—1.57	—31.4	—24.4
Flag 3	Flag 2	6.225	32,860	—0.75	—15.0	—8.0
Flag 2	Flag 1	1.004	5,300	1.38	27.6	34.6
Flag 1	Edison	5.62	29,670	—1.16	—23.2	—16.2
Edison	Magunden	3.1	16,370	—0.83	—16.6	—9.6
Magunden	Kern Jct.	3.4	17,950	—0.10	—2.0	5.0
Kern Jct.	Bakersfield	0.7	3,700	—0.07	—1.4	5.6
Bakersfield to Enginehouse 60 min.		.....	.....	.....	.....	.....
Standing at station 106 min.		.....	.....	.....	.....	.....

such tests are made with picked locomotives, especially adjusted for the test and operated by the best crews.

It is not desired to give the impression that the values of factors given as the result of this investigation are absolute and applicable to all conditions. It is believed that this method of testing attacks the problem from an entirely different angle, from which it is possible to make, of certain factors, analysis in detail not otherwise possible.

Undiscriminating application of the results of this study easily may produce extremely inaccurate results; for example,

TABLE VII—PART 4

Westbound

Distance miles A	Total weight of train tons F	Total tractive effort pounds G E × F	Million ft. lb. at drivers constant speed H B × G/10⁶	Hp. hrs. at drivers constant speed I H/1.98	Thermal hp. hr. for 5.57 per cent efficiency J + only I/0.0557	Computed fuel gallons K J/0.01765
....	.....	.....	.....	.....	.....	90.0
....	.....	.....	.....	.....	.....	10.0
....	.....	.....	.....	.....	.....	21.0
0.709	1,000	30,000	112.2	56.7	1,017.5	17.7
8.637	1,000	50,000	2,281.0	1,151.5	20,670.0	259.7
1.914	1,000	17,200	173.8	87.7	1,574.7	27.4
0.852	1,000	44,400	199.3	101.0	1,811.3	31.6
1.488	1,000	17,000	133.6	67.5	1,211.2	21.1
1.486	1,000	6,000	47.1	23.8	427.1	7.4
1.136	1,000	28,800	172.8	87.3	1,566.7	27.3
2.078	1,000	15,400	169.0	85.3	1,531.7	26.6
1.8	1,000	—5,400	—51.3	—25.9	.....	9.9
1.225	1,000	—17,400	—112.6	—56.9	.....	6.8
23.355	1,000	—30,400	—3,748.0	—1,892.5	.....	86.2
2.179	1,000	—10,200	—117.3	—59.2	.....	9.1
0.892	1,000	—24,400	—115.0	—58.0	.....	2.1
6.225	1,000	—8,000	—262.9	—132.8	.....	26.0
1.004	1,000	34,600	183.4	92.6	166.7	28.9
5.62	1,000	—16,200	—480.7	—242.7	.....	24.2
3.1	1,000	—9,600	—157.2	—79.3	.....	10.5
3.4	1,000	5,000	89.8	45.3	813.7	14.1
0.7	1,000	5,600	20.7	10.5	187.8	3.3
....	.....	.....	.....	.....	.....	20.0
....	.....	.....	.....	.....	.....	75.5
						956.4

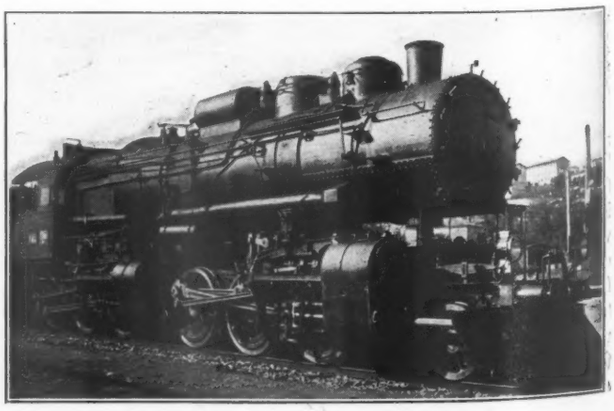
where the conditions surrounding the particular problem bear only a remote resemblance to those of the line over which the tests were made. Weather, grade, service and many other

LIST OF FACTORS

TABLE VIII

	Unit	Value
First Group		
Fuel to fire up with water at 60 deg. fahr.	Gallons	167
Fuel to fire up with water at 120 deg. fahr.	Gallons	131
Fuel to fire up with water at 180 deg. fahr.	Gallons	96
Second Group		
Fuel to hold under steam, in enginehouse, without auxiliaries—per hour	Gallons	17.4
Fuel to hold under steam, out-of-doors, with auxiliaries —per hour	Gallons	36.6
Fuel to hold train on siding—per hour	Gallons	42.8
Third Group		
Train resistance—Hood & Schmidt	Pounds	7
Total train and locomotive resistance—level track	Pounds	11.7
Average overall thermal efficiency	Per cent	5.57
Maximum overall thermal efficiency	Per cent	6.41
Fuel per 1,000 ton miles per per-cent grade without friction	Gallons	14.7
Locomotive internal friction in terms of maximum drawbar pull	Per cent	9
Fuel cost of meet per 1,000 ton train on grades of 2 per cent or over	Gallons	18.3
Fuel cost of meet per 1,000 ton train on light grades	Gallons	0.0
Average operating efficiency—fuel	Per cent	92.5

conditions have their effect upon train operation. Similar tests should be made in passenger and freight, mountain and valley service, also with other types of power.



Mallet Locomotive With Brotan Boiler for the Hungarian State Railways

Tests on a Refrigerator Car Model*

Experiments Indicate That the Side-Draft Bunker System is Superior to the Present Arrangement of End Bunkers

By P. X. Rice

THE tests on a model of a side-bunker refrigerator car described in this paper bring out marked advantages of this arrangement as compared with the present designs of end-bunker cars. These advantages are: (1) Quicker cooling of the load; (2) colder temperatures, especially in the upper layers of the load; (3) more uniform distribution of temperature through the load; (4) saving of ice by reduc-

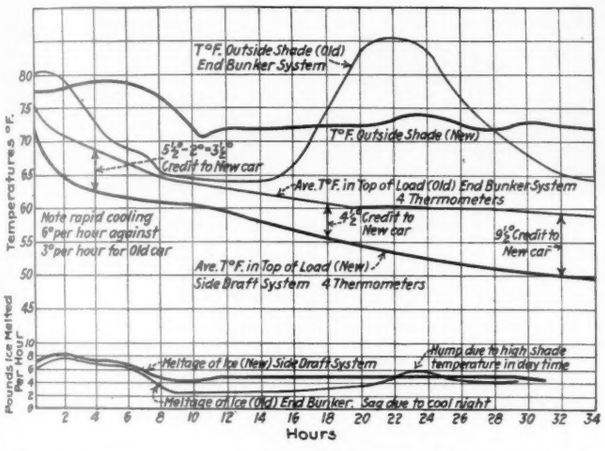

T°F. Outside Shade (Old) End Bunker System
T°F. Outside Shade (New)
5½°-2°=3½° Credit to New car
Ave. T°F. in Top of Load (Old) End Bunker System 4 Thermometers
Note rapid cooling 6° per hour against 3° per hour for Old car
4½° Credit to New car
9½° Credit to New car
Ave. T°F. in Top of Load (New) Side Draft System 4 Thermometers
Meltage of Ice (New) Side Draft System
Hump due to high Shade temperature in day time
Meltage of Ice (Old) End Bunker. Sag due to cool night
Temperatures °F.
Pounds Ice Melted Per Hour
Hours

Fig. 1—Comparison of End-Bunker System with Side-Draft System on October 10, 1922

tion of transmission through the floor; (5) entire length of car floor made available for loading; (6) length of cars not limited.

So far as the tests on this car indicate a conclusion, the

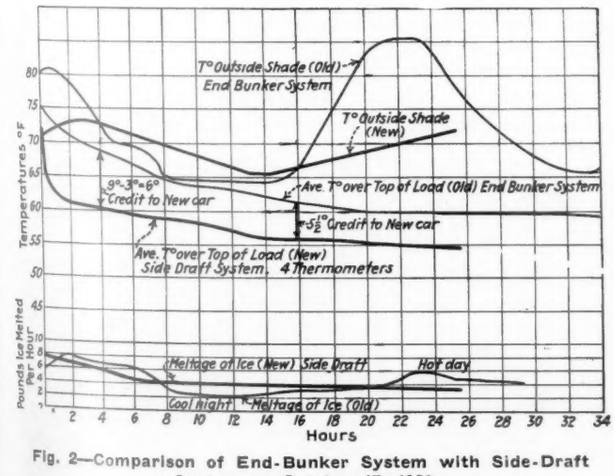

T° Outside Shade (Old) End Bunker System
T° Outside Shade (New)
9°-3°=6° Credit to New car
Ave. T° over Top of Load (Old) End Bunker System
5½° Credit to New car
Ave. T° over Top of Load (New) Side Draft System. 4 Thermometers
Meltage of Ice (New) Side Draft
Hot day
Cool night
Meltage of Ice (Old)
Temperatures °F
Pounds Ice Melted Per Hour
Hours

Fig. 2—Comparison of End-Bunker System with Side-Draft System on October 17, 1922

side-draft system has all the above advantages over the ordinary end bunker arrangement, as shown graphically in Figs. 1, 2 and 3 which show the principal results instead of the large number of more or less unimportant thermometer readings taken during the test.

Test Car Arranged for End Bunker System

The model car was built to a scale of one-fourth the linear dimensions of the average of a large number of railroad cars of the end-bunker type. Inasmuch as this was designed to be a comparative test of a model, with different bunker arrangements, no attempt was made to duplicate the insulation commonly used on actual cars. Inside dimensions were as follows:

Total length inside, 10 ft. 0 in.
Length between bulkheads, 8 ft. 6 in.
Height, inside to ceiling, 21 in.
Width, inside, 24 in.
Clearance of floor rack above floor, 1¼ in.
Opening under bulkhead, 3 in.
Opening above bulkhead, 3 in.
Insulation of floor, sides and ends
1 in. pine car wall and 1 in. air space formed by two thicknesses of building paper.
Insulation fo roof, 1 in. pine ceiling, one 1 in. air space and one ¼ in. air space, using one thickness of building paper per air space.

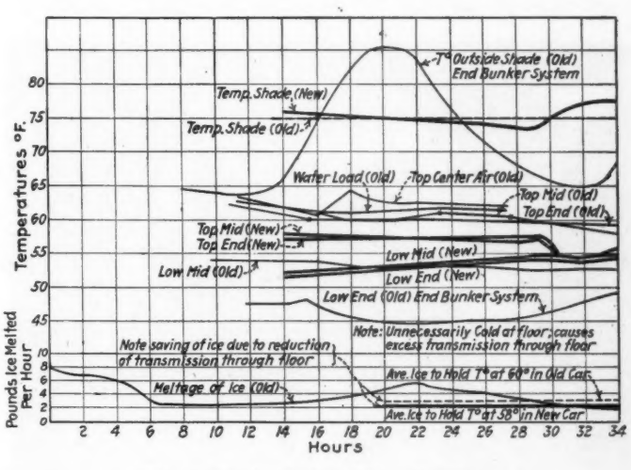

T° Outside Shade (Old) End Bunker System
Temp. Shade (New)
Temp. Shade (Old)
Water Load (Old)
Top Center Air (Old)
Top Mid (Old)
Top End (Old)
Top Mid (New)
Top End (New)
Low Mid (New)
Low Mid (Old)
Low End (New)
Low End (Old) End Bunker System
Note saving of ice due to reduction of transmission through floor
Note: Unnecessarily Cold at floor; causes excess transmission through floor
Ave. Ice to Hold T° at 60° in Old Car
Meltage of Ice (Old)
Ave. Ice to Hold T° at 38° in New Car
Temperatures °F.
Pounds Ice Melted Per Hour
Hours

Fig. 3—Transmission Through Floor

Insulation of bulkhead, 1 in. pine.
Doors, none. Access to inside by removing roof which was fitted to car with sealing strips to prevent influx of atmosphere.
Bunker, wire basket type, depth, 15 in.
Bunker, wire basket type, length, 20 in.
Bunker, wire basket type, width, 7 in.
Cargo: 10 bushels of potatoes spread loosely over the floor rack to a height of approximately 14 in., except at center of car where an open space was left for circulation of air as usual.

Test Car Arranged for Side Draft System

After being tested with the end-bunker system, the bunkers and floor rack were taken out of the model car. Then the new type of side-draft and overhead-bunker system was built into one side and top of the car. Fig. 4 shows a general view of the inside of the car with load. Fig. 5 brings out the details of one of the new bunkers without the clearance screen, or grate, used to prevent ice from clogging the duct.† The best type of bunker tried is shown in Fig. 6. Fig. 7 shows the location of the bunkers with this arrangement and

*This is part of a bulletin "The Economics of Refrigerator Car Installation" being prepared by the Pennsylvania State College Engineering Experiment Station under the direction of Prof. A. J. Wood, head of the Mechanical Engineering Department, who has for many years carried out investigations covering the design of refrigerator cars.

†The screen bag shown in the duct opening is not recommended, because with ice in the duct opening the air-flow down the duct is restricted so much that, although the air is bound to be much colder, refrigeration of the load is not as rapid as with the grate type of bunker shown in Fig. 6.

indicates the position of the thermometers on the front and back sides and the two ends.

Location of Thermometers

Fig. 7 locates the thermometers named on the data sheets and curves, but an explanation is also necessary. "Outside shade temperature" was simply the temperature of the roof. Sunshine was kept off the car in order to simplify conditions. The "top end" and "top mid-temperatures" represent the temperatures of the top layer of potatoes near the front side of the car adjacent to the end of the load and of the upper layer of potatoes near the doorway, respectively. "Back top" corresponds in position to the "top end" except it is read from the back side of the car near the ends. "Top center" is the temperature of the usual warm air space between the doors, near the ceiling as shown. "Low end" and "low mid" temperatures were taken in the lower layer of potatoes. Under "Exploration" the observations named "Back side mid" and "end mid" are load temperatures about half way between the top layer and the lower layer of potatoes.

A large number of extra temperature explorations were made in all parts of the car, principally to insure that no unexpected temperatures existed. These investigations helped to improve the design of bunkers and space for circulating air, but would not interest the average reader and are not shown on the curves.

Procedure in Testing

Ten bushels of potatoes were dumped into the car, filling all the floor rack area, except at the doorways, to a height of approximately 14 in. Thermometers were placed in the holes marked "top end," "top mid," "low end," "low mid,"

Fig. 4—General View of Side-Draft Car Model

"top center air," and "shade," temperatures of those portions recorded. Ice was broken into pieces of approximately 3 in. and 40 lb. was placed in each of the two bunkers. During the early periods of the tests, the above cycle of observations was repeated as rapidly as possible, but as soon as the temperatures of the load began to reach stable temperatures, the time interval between cycles of readings was increased to several hours. Some of the tests were continued with stable load temperatures as a measure of heat transmission through the car walls. Shade temperature on the later tests was regulated to maintain a temperature comparable to the earlier tests; for this purpose the steam heating system of the building was controlled.

Meltage of ice was recorded by catching and weighing the water dripping from the pans under the bunkers. Sometimes the small drip pipes became clogged and caused irregular meltage rate graphs, but this occasional error was not sufficient to interfere with the work, as the accumulated water in the drip pan was weighed as soon as the drip pipe could be cleared. The ice was allowed to melt down considerably nearer exhaustion than occurs in railroad service so that the effect of low ice could be observed, but the original charge of ice was sufficient to permit a test of the rapidity of cooling of the load. To test the transmission of heat through the walls of the car equipped with the side-draft system of

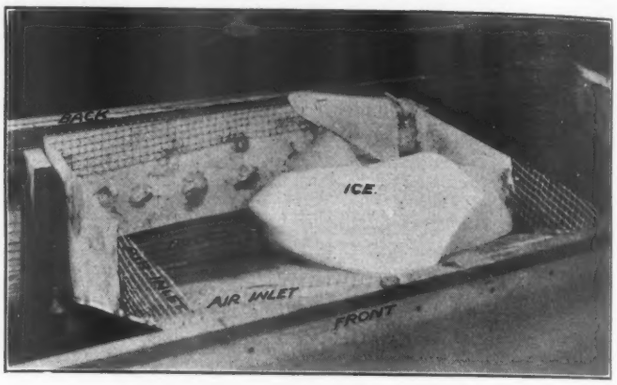


Fig. 5—Side-Draft Bunker Without Grates

bunkers, it was necessary to let the ice become exhausted until the top of the load warmed up to the temperature carried by the less effective end-bunker system, then the down-draft ducts were closed with boards to stop duct circulation, and a single 20 lb. cake of solid ice was placed in each bunker to maintain the temperature.

Test Results

1. *Rapid Cooling.* In the comparative tests of the model car, it was found that the side-draft system cooled the load at the rate of 6 deg. F. to 10 deg. F. the first hour, as compared with 3 deg. F. per hour for the end-bunker system. (See Figs. 1 and 2.) Proper allowance was made for the fact that in the new car the temperature at the beginning of the test was 2 deg. F. to 3 deg. F. cooler than the load in the end-bunker system. During this period the consumption of ice per hour was substantially the same in the two systems, although the new car was doing more work of refrigeration. This is probably due to the excessively cold floor in the old car (see Fig. 3), which caused excess transmission through the floor and melted some of the ice not used for refrigeration.

In devising the side draft system with the bunkers near the top of the car, several arguments which predicted rapid cooling and cold carrying temperatures presented themselves as follows:

(a) The distance traversed by the air circulating from the bunker down through the draft-duct at the side of the car, along the floor to the opposite side or to the end or to the middle of the car, is much shorter than in the end-bunker system. The distance traveled in a complete circuit of the new model car is only approximately 8 ft. instead of 14 ft. as in the end-bunker system. For long express cars the advantage would be even greater. Thus, the frictional resistance to circulation is reduced. Furthermore, each pound of cold air has to absorb less heat and therefore is more effective for refrigeration.

(b) The cross sectional area of the above mentioned air circuit may be made quite large simply by extending the bunker and draft ducts along the length of the car as far as desired; even then, there is more floor space available for load than is possible in the end-bunker car. In practice the

proportions of dimensions shown in Fig. 7 are expected to satisfy the temperature requirements of all perishable products.

(c) Circulation depends also on the driving pressure, in this case the difference in the weights of cold and warm columns of air. In the end-bunker system when the ice is half exhausted, only the lower half of the column of air in the bunker space is cold and the effective driving force is considerably reduced. This results in considerably slower refrigeration (see Fig. 8, which compares the temperatures of two similar cars in a transcontinental test trip). Car No. 8505 was not re-iced at one of the regular stations where car No. 7757 was re-iced. It will be seen that the partial exhaustion of ice in the bunkers of car No. 8505 did not interfere with chilling of the air while passing through the bunkers; in fact, the record shows that the air emerging from the bunkers with low ice was slightly colder than in the bunkers full of ice. But circulation was affected unfavorably, as shown by the warmer load temperatures of car No. 8505. If the bunkers of car No. 7757 had been kept even fuller

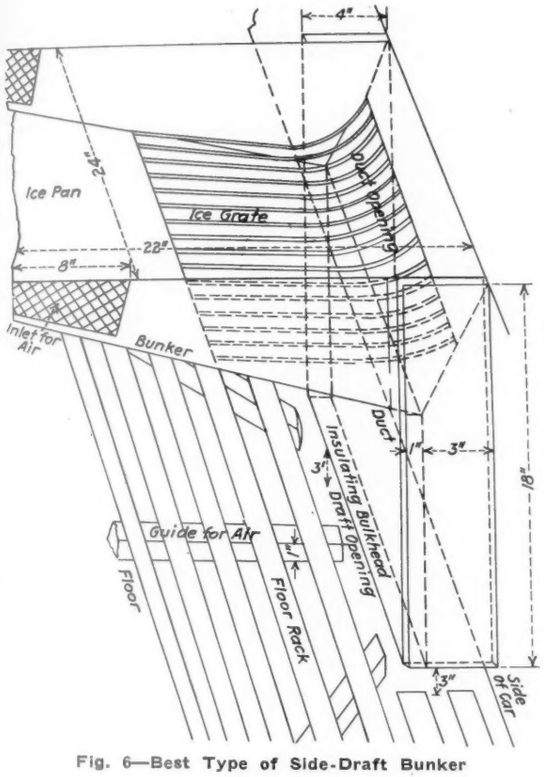


Fig. 6—Best Type of Side-Draft Bunker

and the bunkers of car No. 8505 had been more nearly exhausted, say one-eighth full, the advantage of having ice placed at the top of the draft duct would have been even more pronounced. In the proposed side-draft system the ice is near the ceiling and the natural convection is not appreciably lessened when the ice in the ceiling bunkers is almost exhausted.

(d) The sheet metal bottom of the bunker has considerable heat absorbing surface. Referring to Fig. 3, it will be seen that even with the draft duct closed in the new car the temperatures in the top layer of load was lower than in the end-bunker car. For certain kinds of perishable commodities it would be desirable to close a damper in the side-draft duct, after sufficient heat had been extracted by the draft system, so that excessively cold temperatures would not be attained.

(e) Uniform distribution of temperatures throughout the load was predicted by tests on the well known type of cars having the refrigerating surfaces near the ceiling.

(f) Floor temperature will not be as low in the side-draft car and if other conditions were the same as in the end-bunker car, the transmission of heat through the floor would not be so great.

(g) On account of the very rapid cooling of the load possible in the side-draft car, it may not be necessary to precool for the shipment of certain perishable commodities if the time between icing stations is not unusually long.

2. *Colder Temperatures.* Figs. 1 and 2 show that the top layer of potatoes were maintained at a temperature from

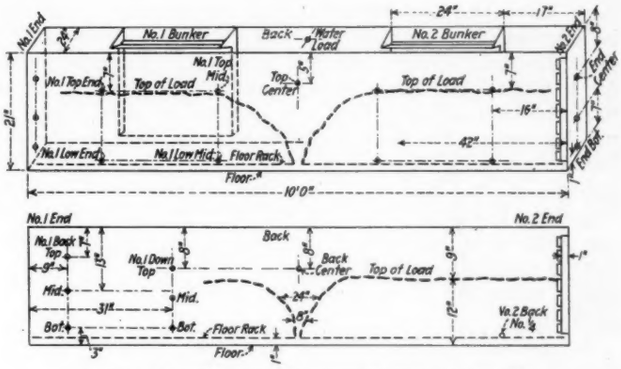


Fig. 7—Location of Thermometers in Model Car

5½ deg. F. to 9½ deg. F. colder in the new car than in the end-bunker system. Particular attention is directed to the top of the load because it is there that spoilage of cargo usually occurs. It is believed that further refinements of the side-bunker system would give it as much advantage in this respect as could be desired. Furthermore, it would be possible to provide more than double the area of heat absorbing surface on the steel bottom of the bunkers and double or treble the cross sectional area of the ducts, so that nearly freezing temperatures could probably be carried in all parts of the car if desired, or the use of salt or brine tanks would probably freeze meat cargoes more securely than ductless systems can, and in a shorter time.

The reason for the colder carrying temperature observed in

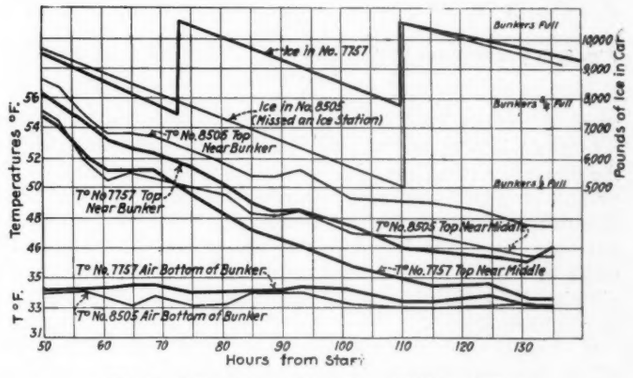

Bunkers Full
Ice in No. 7757
Ice in No. 8505 (Missed an Ice Station)
T° No. 8505 Top Near Bunker
T° No. 7757 Top Near Bunker
Bunkers ¾ Full
Bunkers ½ Full
T° No. 8505 Top Near Middle
T° No. 7757 Air Bottom of Bunker
T° No. 7757 Top Near Middle
T° No. 8505 Air Bottom of Bunker
Temperatures °F.
T°F.
Pounds of Ice in Car
Hours from Start

Fig. 8—Advantage of Ice Near Ceiling of Car

the new car is the same as that described in connection with the rapid cooling.

3. *Uniform Distribution of Temperatures.* Fig. 9 shows how evenly the temperatures are distributed in the various parts of the load. For comparison the temperatures in the old end-bunker type of car are shown in Fig. 10. In the side-draft system the load temperatures did not at any time differ more than 5 deg. F. from the top of the load to bottom of the load, whereas the end-bunker car permitted almost 20 deg. F. temperature difference. In actual refrigerator cars of the end-bunker type, it is common to find a difference of 35 deg. F. between the top and bottom of the load

at the beginning of a trip and 20 deg. F. at the end of 48 hours.

4. *Saving of Ice.* The primary purpose of the side-draft system is to give superior refrigeration rather than to save ice. If the new cars are built and operated so as to produce considerably greater refrigeration than is supplied by the old end-bunker cars, with no increase in insulation, the consumption of ice will be as great or greater (see Figs. 1 and 2). Each unit of work of refrigeration requires a definite amount of ice meltage. But a large part of the ice is also consumed on account of transmission of heat through the floor, sides, and roof of the car, and any economy of ice must be obtained by reducing this loss to a minimum. In the new side-draft system the loss of ice due to transmission, for a given load temperature, is reduced by having the ice near the load where useful heat abstraction takes place and not by cooling the floor excessively as is done in the end-bunker system. For equal temperatures in the top, or critical portion of the load, the side-draft system saves ice (see Fig. 3). With the side-draft system it may be necessary to use dampers in the draft ducts to reduce the rate of refrigeration to equal the refrigeration of the end-bunker cars, especially when the desired carrying temperatures have been attained.

5. *Length of Car Available for Load.* Calculations show that 95 per cent of the entire floor space is available for load

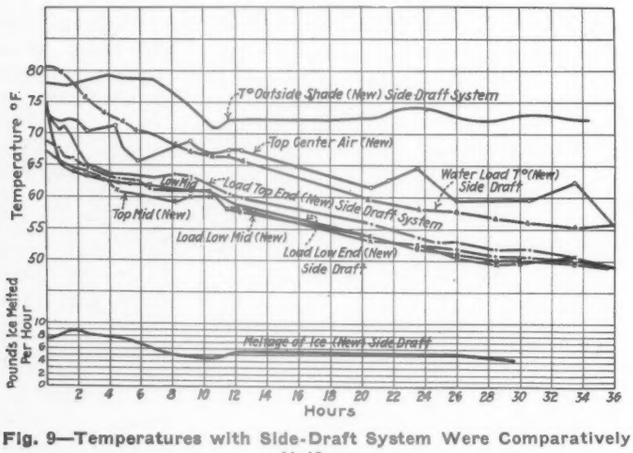

Temperature °F.
T° Outside Shade (New) Side Draft System
Top Center Air (New)
Water Load T° (New) Side Draft
Low Mid
Load Top End (New) Side Draft System
Top Mid (New)
Load Low Mid (New)
Load Low End (New) Side Draft
Pounds Ice Melted Per Hour
Meltage of Ice (New) Side Draft
Hours

Fig. 9—Temperatures with Side-Draft System Were Comparatively Uniform

as compared with 80 per cent in end-bunker cars. This represents an important economic gain, if the space occupied by the draft ducts at the side of the car does not disturb the present standard loading customs of shippers who might dislike to re-arrange their fruit boxes on a longer and somewhat narrower floor. It is possible to dispose of the ducts in the walls of the car if they be made thin, but if this is done the air circulation might not be much better than in the present end-bunker cars.

6. *Length of Cars not Limited.* It is conceivable that 60 ft. cars can have bunkers of the side-draft system placed much nearer to the center of each half of the load and that the length of draft ducts may, for especially difficult service, be placed along the entire length of the car on one side except at doors. The ice hatches in the roof need not be very numerous because the bunkers do not have to be as long as the ducts.

Recommendations

It is recommended that railway car owners and car builders test the side-draft system in an actual railway car with the same dimensions and insulation as one of their standard end-bunker cars, comparing the two types of cars during an actual trip with some especially perishable load, observations being made to check the first four claims previously made. Experience may suggest additional improvements. It is suggested that further study be made of various types of bunkers such as shown in Figs. 5, 6 and 11. The problem may be to arrange for the air passing through the bunker to be cooled almost to the temperature of the ice or ice and salt but without impeding the circulation of the air. However in the tests it was found that low resistance paths through the bunker provide quicker refrigeration than is possible with the air forced into more intimate contact with the ice at the expense of air friction. Perhaps the scheme in Fig. 11 which causes the air to flow up through the ice

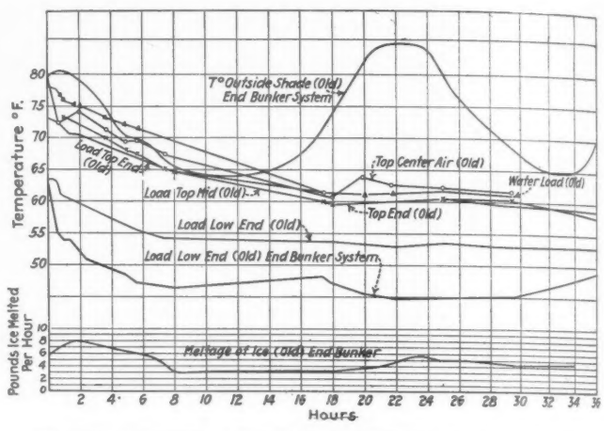

Temperature °F.
T° Outside Shade (Old) End Bunker System
Load Top End (Old)
Load Top Mid (Old)
Top Center Air (Old)
Water Load (Old)
Top End (Old)
Load Low End (Old)
Load Low End (Old) End Bunker System
Pounds Ice Melted Per Hour
Meltage of Ice (Old) End Bunker
Hours

Fig. 10—Temperatures with End-Bunker System Showed Considerable Variation

and then down through the ice again before entering the draft duct would be superior to the bunker used in the tests, but the increased air friction would probably reduce the rapidity of refrigeration.

So far as can be predicted no further development is required to make the side-draft system superior in all respects

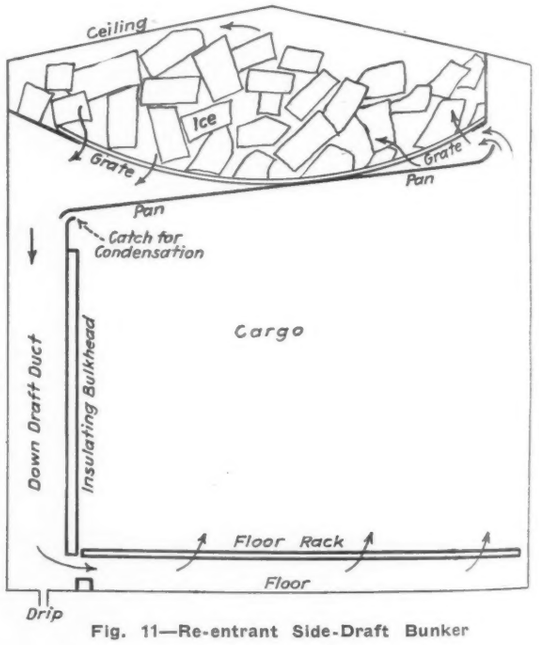


Fig. 11—Re-entrant Side-Draft Bunker

to the end-bunker type, but the prospective owners of such cars will profit by developing the car to its utmost before building them in large numbers. Changes may be required to conform to structural requirements. The ice must be supported in the top of the car and hatches arranged so that the ice crews can work effectively. It may be necessary to

provide dampers in the draft ducts to prevent excessively low temperatures, or the size of draft ducts and bunkers may need to be reduced.

After the best possible bunker and draft system has been tested to satisfaction the system can then be tried in cars of 50 ft. or 60 ft. lengths. It is believed that the side-draft system will be especially advantageous for long cars. Three lengths of cars and locations of bunkers are shown in Figs. 12, 13 and 14. It was found by test that a considerable improvement was made by providing an "up duct" (see Fig. 14) to aid circulation at the ends of the car. It is also essential to

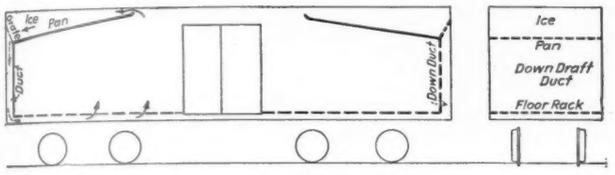


Fig. 12—End-Draft Bunkers for Short Cars

have guides or vanes under the floor rack to cause a proportionate share of cold air to flow toward the ends of the car (see Fig. 6).

As yet it is not known what provisions must be made to care for the inevitable condensation on the under surface of the bunker. During tests on the model car no water dripped onto the potatoes though there was a slight deposit of dew on the bottom of the bunker. If the condensation had increased considerably, as it might with a load of moist vegetables, the moisture on the bunker bottom would have run

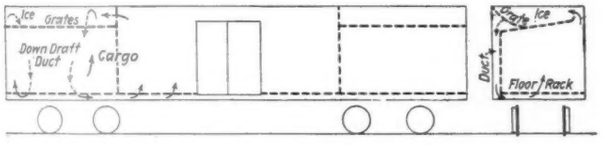


Fig. 13—Side-Draft Bunkers for 50-ft. Cars

down to the duct where it would drip down between the insulated bulkhead and the metal chute or "down duct" into the drip pan at the bottom of the duct where all the ice water was caught for drainage. Whether dew would be shaken off the inclined bunker bottom by the motion of the train before gliding to the duct is not known. Possibly a pan would be required under the bunker with a few inches of space to allow air to circulate.

The bunker iron must be thick enough to be water tight despite abuse. In designing the ice grates in the bunker they should be made inclined so that the ice will always keep sliding down toward the draft duct and keep that opening fairly well covered with ice as long as any ice remains in

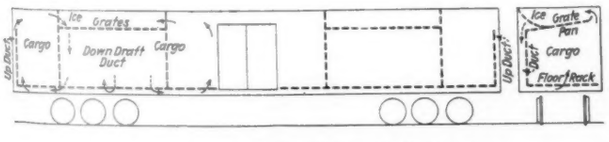


Fig. 14—Side-Draft Bunkers for 60-ft. Cars

the car. Bars of iron are better than wire netting which would cause the ice to lodge some distance from the center of the draft duct.

No experiments were made on the ventilation performance of the new car. Probably the best and simplest way to accomplish ventilation is to use the ice hatches, the forward hatches discharging air to the bottom of the forward half of the car while the rear hatches exhaust air from the bottom of the rear half of the car.

There remains the problem of heating the car to protect its cargo in cold season. No attempts have been made to improve on the effectiveness of the heating systems used in existing types of cars. If charcoal heaters are to be used in the ends of the new cars as is done in the end-bunker cars, it will be necessary to insert bars across the car to prevent shifting cargo from demolishing the heaters.

The Inspection of Freight Cars*

By Emil Erickson

Foreman Car Department, New York Central, Chicago, Ill.

THERE is so much that can be said about freight car inspection that I am not going to try to cover everything, but will confine myself to the principal subjects.

First—Inspection of cars on arrival in receiving yard.

Second—Inspection of cars in classification yard.

Third—Inspection of cars at miscellaneous loading points.

Fourth—Inspection of cars on repair or shop tracks.

My thought in setting out the plan outlined below is that it is desired to get the best possible inspection and get cars in such condition so as to enable the transportation department to make the highest possible speed with trains over the road and also to prevent the loading of bad order cars.

In order to secure the best results in this respect it must be always borne in mind that there should always be sufficient time allowed on trains and sufficient help to do the necessary work in the proper manner.

Inspection in Receiving Yard

On arrival of cars in receiving yard, the track must be properly protected by flag or light and where work is done that requires men going underneath cars, the track should be locked for the protection of the men doing this work. It is well to give the inbound trains an air test in order to locate any defective air brakes. Where conditions permit, these defective brakes can be taken care of out in the train yard, otherwise they must be sent to the repair track. Giving the inbound train this air brake test on arrival, prevents getting any of these defective cars made up into a train and later on making it necessary to switch them out.

The train should be carefully inspected for any other defective cars that have to go to the repair track for repairs. All defects that can be repaired in the train should be marked "repair in train." Any loaded cars having defects such as should be repaired before reloading, should be carded to the repair track or shop when empty in order to avoid reloading of this car before repairs are made. Empty cars should be carefully inspected and carded for the class of commodity they are fit to carry. Bad order cars should be carded to repair tracks or shops for repairs.

It is the intent of the above outline to get all cars properly inspected and carded on arrival in the receiving yard so as to prevent any unnecessary switching and handling of cars. No loaded car should be cut out and sent to the repair track that can be repaired in the train, as this means delay as well as extra expense of handling. Cars inspected for the loading of powder and other explosives should never be inspected except in daylight, as it is almost impossible to make proper inspection by lamplight, and the man making this inspection should be familiar with all instructions governing this class of lading. This should also refer to cars for the loading of flour, grain, merchandise and other classes of lading that require a car with a watertight roof, sides and ends. In making inspection of cars for this class of lading, inspectors should always be instructed to keep the proper records and follow out instruction issued by the railroads they are working for.

Inspectors should be instructed to give careful attention to

*Paper submitted in Prize Contest on Car Inspection.

the inspection of running gears, draft gears and safety appliances; particular attention should be given to the brake connection pins and cotters, brake beams and hangers, brake hanger bolts and cotters, box bolt and column bolt nuts, arch bars, truck sides and wheels, knuckle pins, etc.

Loose and worn box bolts and missing oil box covers generally indicate flat or shelled out wheels. Close inspection should be made for wheel defects such as worn or broken flange, seamy and hollow treads, broken brackets and plates. Defective draft rigging can generally be noticed by broken striking plates, coupler pulled out too far or coupler horn back solid against the striking plate.

Inspecting Cars in Interchange

Cars coming from connections should be carefully inspected for delivering line defects to protect the receiving line against such defects that are chargeable to the delivering line. However, in this connection it might be stated that inspectors at interchange points should be taught not to be too technical in receiving cars from connections as there is no need under the present A. R. A. rules for any inspector to hold up cars in interchange unnecessarily. This refers particularly to loaded cars as it is more important to get the load to destination than to hold the car up for some minor defect.

Empty cars offered in interchange on orders for certain classes of lading should be carefully inspected to see that they are fit for such lading to prevent them from being moved from the point of interchange to the loading point and afterwards rejected at the loading point.

Inspectors should be carefully instructed in keeping proper records as to cars carded bad order, defect and cause, cars carded for lading, etc. Reports should be made out for all cars damaged in yard or train service, giving full information as to how the damage occurred. All necessary information should always be shown on bad order cards as well as damage reports as to how damage was caused and all records should be carefully checked to see that they conform to the A. R. A. rules.

Car inspectors should never be expected to keep records of seals, records of contents, destination or other transportation records, as the inspector has enough to keep his mind on if he takes care of his own work properly. This, of course, does not refer to small unimportant points where the work is limited.

Inspection in Classification Yard

After the work has been properly completed in the receiving yard and trains are made up in classification yard, the air brake men should give the train the standard A. R. A. air brake test and in addition to this make an inspection of the train for any defects that may have developed in yard switching, in order to prevent any cars that may have been damaged from leaving the terminal yards for road movement in a defective condition.

In some yards local conditions may not permit making repairs in the receiving yard on account of limited room and other operating conditions. In these cases the defects can be taken care of in the classification yard after the train is made up and turned over to the inspectors by the transportation department but in either case there should be sufficient time allowed to do the work properly. It is a great deal better to get the train in A-1 condition before allowing it to leave the terminal than it is to have delays on the division, oftentimes making it necessary to set out cars on the road which in most cases causes delay to the shipment and resultant damage claims.

Inspection on Industry Tracks

If all cars are inspected and handled as outlined above there should be no need of reinspecting empty cars set at freight houses, industries and other points for loading. The only inspection needed at these points should be the inspection of cars unloaded and reloaded to see that they are fit to carry the load that the shipper intends to put into the unloaded car and for such defects as may develop in switching. Inspectors inspecting at industries, freight houses and other points should be thoroughly familiar with loading rules to see that they are lived up to in all cases, and also see to it that cars that are set for loading are the proper kind of cars for the class of lading that is to be loaded.

Inspection on Repair Tracks

Loaded cars on repair tracks or shop tracks should be inspected by a competent inspector before repairs are started and all work that is to be repaired should be written up on the original record repair card. The defects and cause of defects in all cases should be plainly stated; for example: The words broken, missing or bent should not be used alone but the condition under which they are broken, missing or bent must be plainly stated.

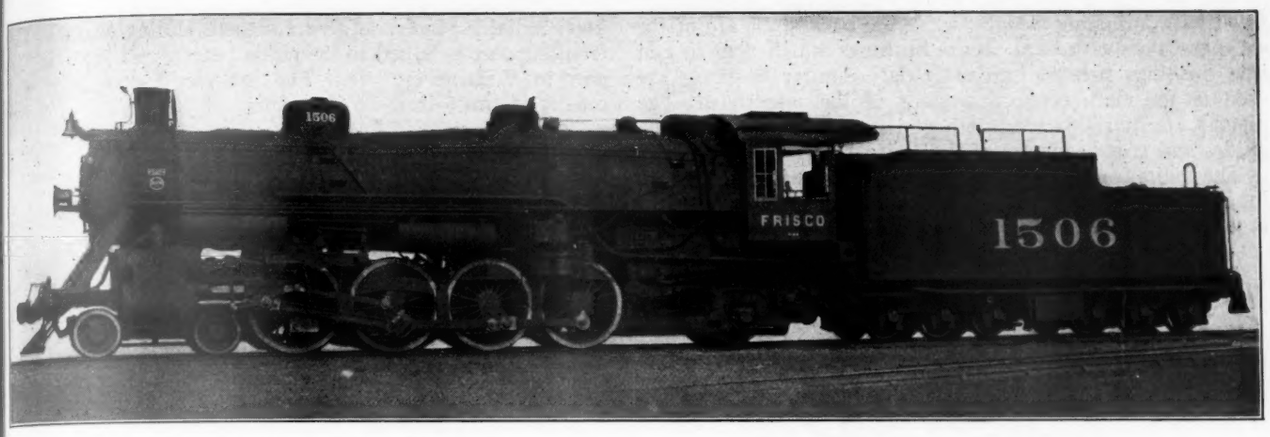
All cars on repair tracks should have couplers gaged as to height and also have knuckles gaged to determine any worn parts. A very satisfactory way of doing this so as not to have half of them overlooked is to assign a man to go over all cars on the repair track each morning to gage coupler height and knuckles and mark on the end of the car, the coupler height as well as the condition of the knuckle. In this way the inspector in writing up the other work can enter this information on his record repair card.

Trucks should be carefully examined as to brake hangers and pins, cotters, and other defects; all journal boxes should be carefully inspected as to condition of packing, journal bearings and other parts. On heavy loaded cars particular attention should be paid to side bearing clearance. In fact no car should be permitted to leave the repair track without having all necessary repairs given attention, in order to keep the car from being set out or placed on the next repair track. Of course in case of loaded cars, judgment should be used so as not to cause delay unnecessarily for defects that will not prevent the car carrying its load to destination or cause damage to its lading.

Empty cars set for light repairs should be thoroughly inspected and repair work to be done should be written up as stated above on the original record repair card. Empty cars undergoing light repairs should always be put in shape for the best class of service possible with light repairs. At most places and at most times the repair track foreman and the inspectors have to govern their work according to the demand for the cars. If there is a heavy demand for cars for a certain class of lading he has to see to it that he gets his cars fixed up for this lading in the least possible time in order to take care of this demand. But he should at all times bear in mind that the nearer he gets his car in 100 per cent condition before releasing it from the repair track the longer it will stay off the repair track.

Empty cars placed for heavy repairs should be properly spotted with sufficient room for doing the necessary work. A first inspection should be made which should consist of writing up the work on the original record repair card and marking out repairs that are visible on the first inspection. After the repairmen have dismantled the car as far as repairs marked up on the first inspection are concerned, a second inspection should be made to mark out defects that are concealed when making the first inspection and are later on uncovered.

When cars are on repair tracks for any kind of repairs, light, heavy or medium, the material checker should always be in close touch with the work in order to get a correct check of material removed and applied for the information of the bill clerk. In order to assure proper work being done at all times, a competent inspector should check the work as to workmanship before cars are released from repair tracks or shops.



Mountain Type Locomotive of 54,100 *lb. Rated Tractive Force*

Mountain and Mikado Types for the Frisco

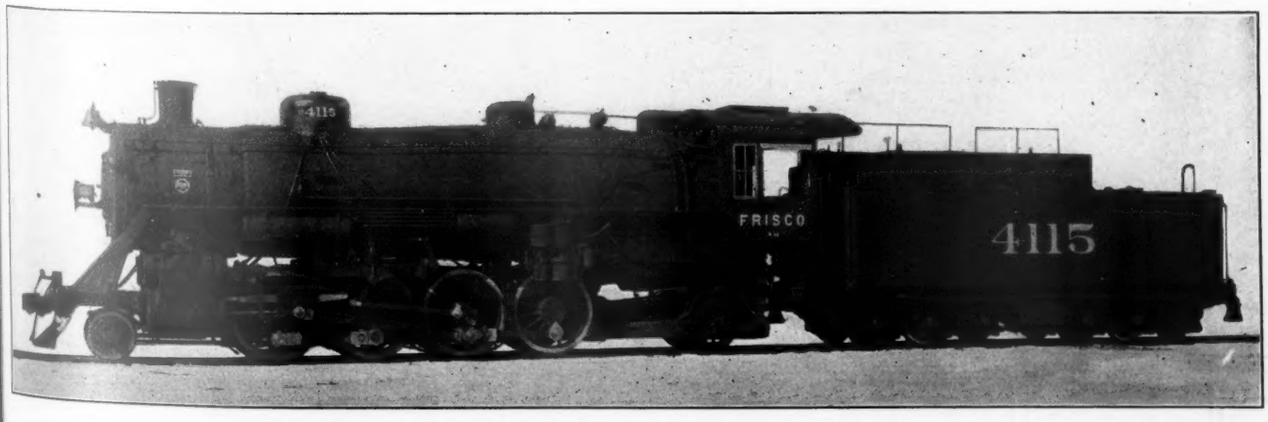
New Oil-Burning Locomotives Based on U. S. R. A. Designs Modified to Suit Railroads' Standards

AN important addition to the motive power equipment of the St. Louis-San Francisco has recently been received from The Baldwin Locomotive Works, which has built 50 heavy locomotives for this road—15 of the Mountain or 4-8-2 type for passenger service, and 35 of the Mikado or 2-8-2 type for freight. In general design, these locomotives are based on the heavy Mountain and Mikado types built for the United States Railroad Administration with details revised throughout to suit the standards of the Frisco Lines.

Both types of locomotives burn oil for fuel, and are built to specifications which, apart from the necessary changes in dimensions, are closely similar. The locomotives are designed for operation on curves of 20 deg. and grades of 2 per cent, and are built with height and width limits of 16 ft.-2 in. and 11 ft.-0 in. respectively. The following are the principal details that are interchangeable in the two types: Throttle, dry-pipe and accompanying fittings; all smokebox details, smokestacks, and boiler fittings, such as plugs, etc.; cab-fittings, cabs (except front sheets), front bumpers and pilots, drawbars and connecting devices between engine and tender, and principal frame cross-ties and frame fillings; cylinder and steam-chest packings, steam-chest heads and bushings, piston valves and power reverse gear; front and back main rod brasses, and front, intermediate and back side rod brasses and crank pins; main driving boxes, brasses and axles, and front and back engine truck boxes, axles and wheels; electric headlight equipment, and such furniture as sandboxes, steps, etc. The tenders are duplicates throughout.

The boilers of both classes are of the conical wagon-top type, with combustion chambers. The firebox sides, crown and combustion chamber are in one piece, and the combustion chamber seam is welded on the bottom center line. The inside throat-sheet is welded to the firebox and combustion chamber, and the tubes are welded at the firebox end. The seam in the fire-door opening, which measures 16 in. by 20 in., is also welded. Provision is made so that arch-tubes and stokers can be subsequently applied, should it be necessary to change the locomotives to coal burners.

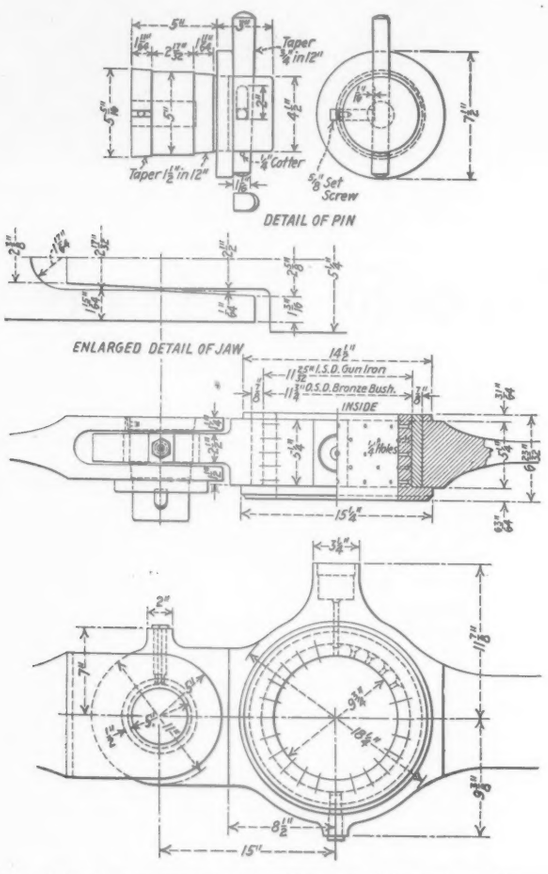
These locomotives are equipped with Baker valve motion, controlled by the Ragonnet power reverse mechanism. The piston valves used on both types have a steam lap of 1¼ in. and are set with a travel of 8¾ in., and with a lead on the passenger locomotives of ¼ in., and on the freight locomotives of 3/16 in. In the former case the exhaust clearance is ⅛ in., while in the latter the valves are line and line on their exhaust edges. The front stubs on the main rods are



Mikado Type Locomotive of 60,000 lb. Rated Tractive Force

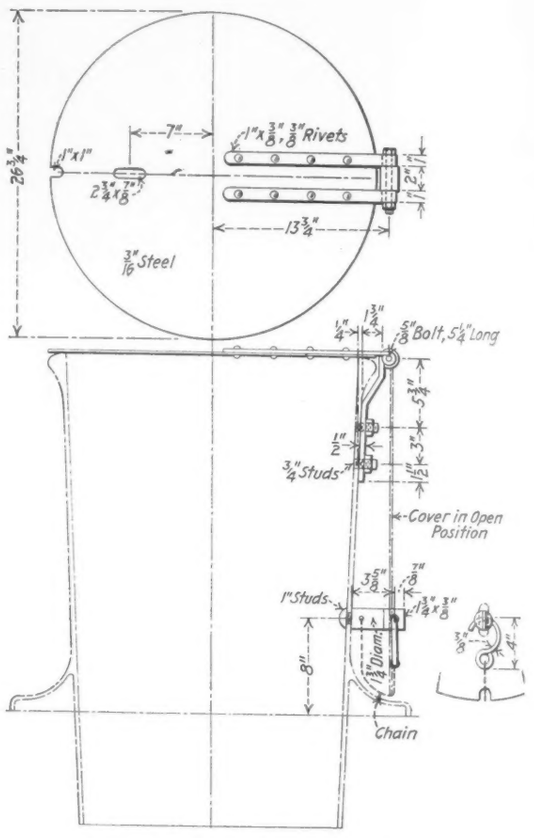
fitted with adjusting wedges, while the back stubs are of the solid end type with hard bronze bushings which float in gun iron bushings pressed into the rods. Similar bushings are used in the main connecting stubs of the side rods. The pistons are of rolled steel with gun iron bull-rings, and the guides and crossheads are of the Laird type.

The main frames of both types are 6 in. wide, spaced 41 in. between centers, and have exceptionally strong transverse bracing. Between the cylinders and the firebox there are



Details of Rod Bearings and Knuckle Pin (Dimensions Shown Are for Mountain Type)

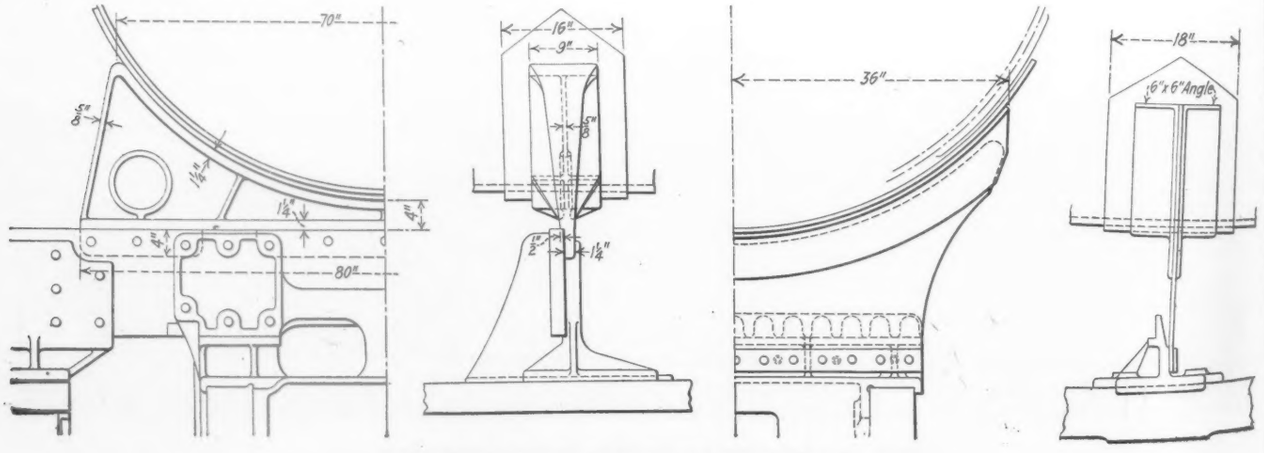
three intermediate boiler supports on the Mikado type, and four on the Mountain type. The front and rear supports, which are each 9 in. wide, and have a length equivalent to about one-third of the boiler circumference, are steel castings, radially planed to give a smooth sliding surface. The front support is bolted to the guide bearer, and the rear support to a frame crosstie. The intermediate supports each consist of two 6-in. by 6-in. angles, which are bolted to ver-



Stack Cover and Fastenings

tical expansion plates. One of these supports on the Mountain type (and the only intermediate support on the Mikado type) is placed under the gusset course of the boiler. The angle irons are riveted to a liner by rivets having countersunk heads on top and the liner is then secured to the shell by rivets placed outside of the angle irons. The vertical expansion plate is then inserted between the angles and bolted into place. Liners are also riveted to the outside of the boiler shell above the sliding supports.

The rear frames are of the Commonwealth cradle type,



Boiler Braces at Guide Yoke and Under Gusset Course

TABLE OF DIMENSIONS, WEIGHTS AND PROPORTIONS

Railroad	St. Louis-San Francisco	
Type of locomotive	4-8-2	2-8-2
Service	Passenger	Freight
Cylinders, diameter and stroke	28 in. by 28 in.	27 in. by 32 in.
Valve gear, type	Baker	Baker
Valves, piston type, size	14 in.	14 in.
Maximum travel	8¾ in.	8¾ in.
Outside lap	1¼ in.	1¼ in.
Exhaust clearance	⅛ in.	0 in.
Lead in full gear	¼ in.	3/16 in.
Cut-off in full gear, per cent		
Weights in working order:		
On drivers	232,100 lb.	244,690 lb.
On front truck	56,700 lb.	25,870 lb.
On trailing truck	51,000 lb.	49,820 lb.
Total engine	339,800 lb.	320,380 lb.
Tender	244,700 lb.	244,120 lb.
Wheel bases:		
Driving	18 ft. 0 in.	16 ft. 9 in.
Total engine	39 ft. 6 in.	36 ft. 1 in.
Total engine and tender	76 ft. 9⅝ in.	72 ft. 3½ in.
Wheels, diameter outside tires:		
Driving	69 in.	63 in.
Front truck	33 in.	33 in.
Trailing truck	43 in.	43 in.
Boiler:		
Type	Con. wagon top	Con. wagon top
Steam pressure	200 lb.	190 lb.
Fuel	Oil	Oil
Diameter, first ring, inside	82 in.	86 in.
Firebox, length and width	120⅛ by 84¼ in.	120⅛ by 84¼ in.
Height mud ring to crown sheet, back	68 in.	68 in.
Height mud ring to crown sheet, front	91½ in.	91½ in.
Tubes, number and diameter	219—2¼ in.	219—2¼ in.
Flues, number and diameter	45—5½ in.	45—5½ in.
Length over tube sheets	21 ft.	19 ft.
Grate area	70.3 sq. ft.	70.3 sq. ft.
Heating surfaces:		
Firebox and comb. chamber	329 sq. ft.	286 sq. ft.
Tubes and flues	4,053 sq. ft.	3,666 sq. ft.
Total evaporative	4,382 sq. ft.	3,952 sq. ft.
Superheating	1,107 sq. ft.	1,048 sq. ft.
Comb. evaporative and superheating	5,489 sq. ft.	5,000
Tender:		
Style	12 wheel	12 wheel
Water capacity	12,000 gal.	12,000 gal.
Oil capacity	4,500 gal.	4,500 gal.
General data estimated:		
Rated tractive force, 85 per cent	54,100 lb.	60,000 lb.
Cylinder horsepower (Cole)	2,824	2,493
Weight proportions:		
Weight on drivers÷ total weight engine, per cent	68.3	76.4
Weight on drivers÷ tractive force	4.29	4.08
Total weight engine÷ cylinder hp.	120.0 lb.	128.5 lb.
Boiler proportions:		
Comb. heat surface÷ cylinder hp.	1.94	2.00
Tractive force÷ comb. heat. surface.	9.86	12.00
Tractive force × dia. drivers÷ comb. heat. surface	680	756
Cylinder hp.÷ grate area	40.3	35.5
Firebox heat. surface÷ grate area	4.7	4.1
Firebox heat. surface, per cent of evap. heat. surface	7.5	7.2
Superheat. surface, per cent of evap. heat. surface	25.8	26.5

arranged for the Delta type B trailer truck with booster application. Boosters have been fitted on three locomotives of each type, and the other engines can subsequently be equipped should this appear desirable. These boosters are supplied with super-heated steam.

The equipment of all these locomotives includes automatic drifting valves on the cylinders, and flange lubricators on the leading drivers. Another interesting detail is an incandescent lamp mounted on the top of the stack in position to throw its light in an upward and rearward direction, so that the fireman can tell at night whether the locomotive is throwing smoke. Careful attention has been given all details with a view to providing comfort and convenience for the crew.

The tenders have one-piece, cast steel frames, and the trucks are of the six-wheel equalized pedestal type with frames of the same material. The oil and water capacities are 4,500 and 12,000 gal. respectively.

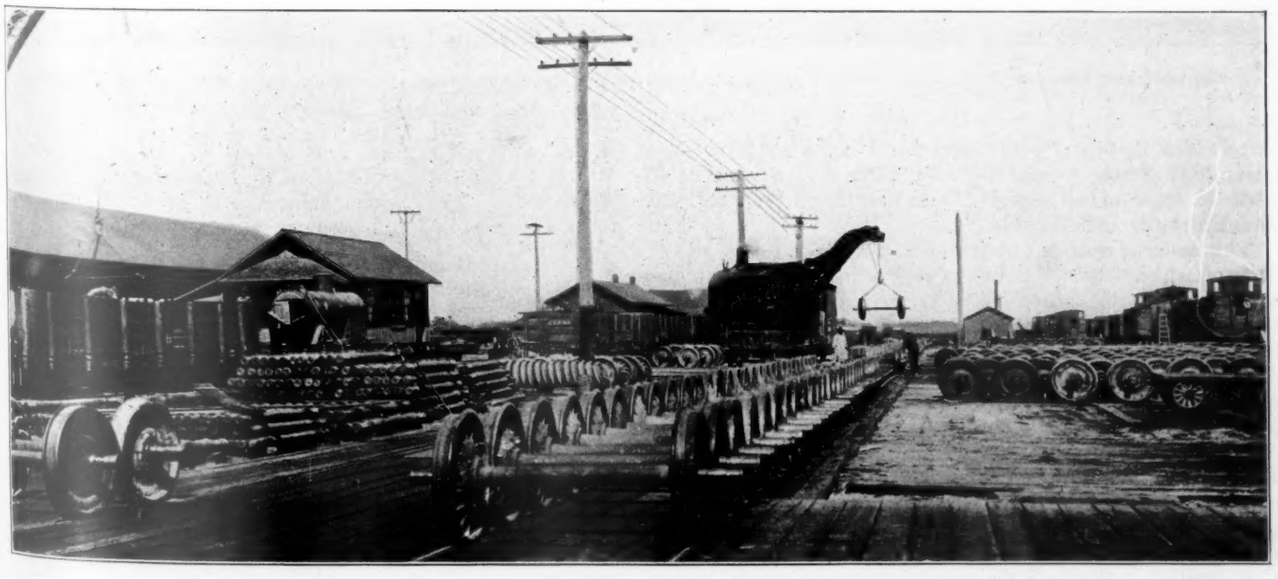
Further particulars of both types are given in the table of dimensions.

Device for Testing Superheater Units and Air Reservoirs

ONE of the most simple and efficient devices yet developed for testing superheater units and air reservoirs is shown on the following page. It was designed and constructed for use in the Readville shops of the New York, New Haven & Hartford.

As shown, the operating mechanism is mounted on a large steel back-plate 1 in. thick, supported on the bottom by three right-angle legs with holes drilled to provide for bolting to the floor. The rugged design of the testing device throughout is evident from the illustration. Moreover it is a compact unit which can be readily moved to the most convenient place in the shop by means of a crane and chain hooks attached to the hangers *M* and *N*. At the time of taking the photograph the tester was not in its final location and it has since been moved to the erecting shop where superheater units can be handled to and from the device with the minimum effort.

Referring to the illustration (p. 360), a superheater unit is

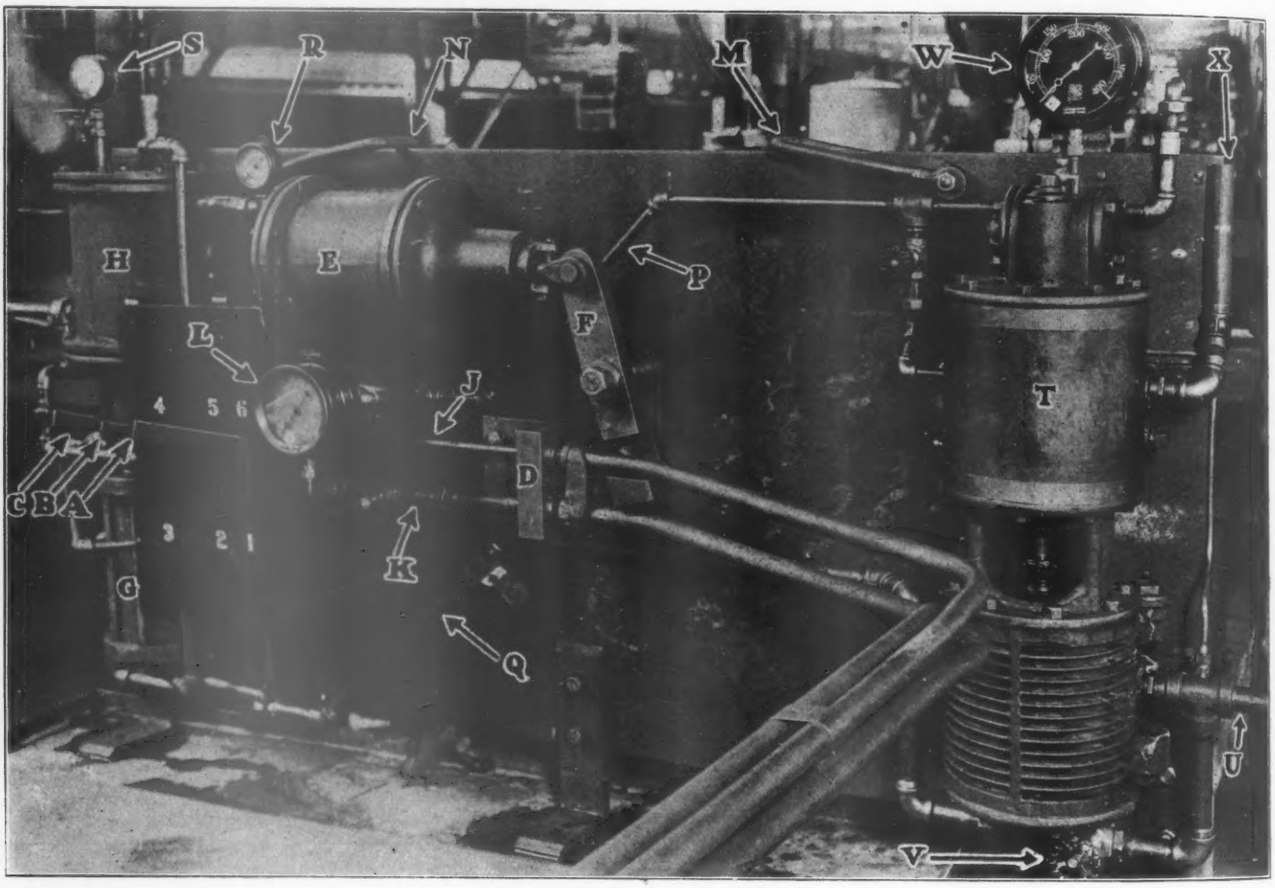


A Systematic Method of Handling Wheels and Axles Is Essential to Efficient Car Shop Operation

shown applied to two false seats in the substantial angle block *D* rigidly bolted to the back-plate. In testing, the unit is held with a heavy pressure against block *D* by means of lever *F*, pivoted as shown and operated from brake cylinder *E*. The final test pressure on the unit is obtained by hydraulic pressure from cylinder *G* direct-connected to brake cylinder *H* by means of a piston rod. The piston in *H* is operated by shop air pressure at 80 lb. from a one-half inch pipe, the pressure being shown by gage *S*. The unit is filled and tested through pipe *J*, being blown out through pipe *K* which is connected through a suitable valve to the exhaust, not shown. The test pressure on the unit is indicated by gage *L*, being between 400 and 500 lb. Shop air pressure at 80 lb. is provided in pipe *P*, the connections being such that this pressure is shown by gage *R*. City water at a pressure of 40 to 50 lb. is provided to pipe *Q* and used for filling the units and hydraulic cylinder *G*.

This tester is operated by means of three levers *A*, *B* and *C*, each of which has two positions and is interlocked with two three-way valves. Three levers are required, for the reason that there are three main pipe connections, namely city water, high pressure water and air required in blowing out units. The arrangement of the interlocking levers to the six valves is extremely ingenious and foolproof, making it impossible to perform the various operations out of their proper order. Moving handle *A* to position *1* supplies air to brake cylinder *E*, clamping the unit quickly and with a heavy pressure which practically eliminates all chance of leakage at the two joints. Handle *B* is moved to position *2* allowing water at street pressure to fill the unit and cylinder *G*. Moving handle *C* to position *3* shuts off the water supply and admits air on top of the piston in cylinder *H* applying hydraulic pressure to the unit. Moving handle *C* back to position *4* exhausts the air in cylinder *H* and closes the connection from cylinder *G* to the unit. The unit is opened to the atmosphere and water and scale blown out by shop air pressure when handle *B* is moved to position *5*. Moving handle *A* to position *6* shuts off air pressure to the unit and releases the air in cylinder *E*, also releasing the unit.

All of the above operations take far longer to describe than to perform. In fact, a unit can be applied on this device, tested and released in a fraction of a minute. Not only is the operation speeded up but the test is much more thorough and severe than that ordinarily accorded superheater units. Cylinder *G* is bushed so that a pressure of 400 to 500 lb. is obtained quickly showing up any defects which exist. This allows defects to be corrected before the units are reapplied and perhaps cause service failures.



A Compact and Efficient Device for Testing Superheater Units at the Readville Shops of the New York, New Haven & Hartford

Testing Reservoirs

Air reservoirs are tested by means of the Westinghouse 9½ in. air compressor *T* which is bushed on the air end to boost the shop pressure to at least 225 lb., at which the reservoirs are tested. Pipe *U* is connected to the reservoir (not shown in the illustration), and in operation valve *V* is opened allowing water to practically fill the tank. Valve *V* is then closed and the air compressor started increasing the pressure on the reservoir to 225 lb. when the standard hammer test is given. The test pressure is indicated by gage *W*, connected by a copper pipe to the tee at the air discharge as shown. Pipe *X* is the exhaust from the air compressor.

Fuel Association Meets in Cleveland

A Large Attendance and Heavy Program; New Field for Conservation at Power Plants Taken Up

ABOUT 400 members of the International Railway Fuel Association were in attendance at the fifteenth annual convention which was held at the Hotel Winton, Cleveland, Ohio, May 21 to 24, inclusive.

Julius Kruttschnitt, chairman, executive committee, Southern Pacific, delivered the opening address, in which he presented a comprehensive survey of the possibilities for economy in the use of railway fuel and outlined quantitatively the direction in which the future developments looking toward reductions in fuel consumption are most likely to meet with success. He also showed that the officers and men who have to do directly with the consumption of fuel are not alone responsible for the reductions in the amount used, but that this responsibility must be shared by every department, including the executive. An abstract of Mr. Kruttschnitt's address will appear in a later issue.

President Clark's Address

In his address, J. N. Clark (Southern Pacific), president of the association, said in part as follows:

Never before has the transportation industry been called upon to carry the load which is now offered and that the industry expects us to do our share is proved by the generous and encouraging response received from practically every railroad president asked to send officers and men to this convention. Let us show our appreciation of this confidence by sending each man back home broadened in his vision, more thoroughly alive to his own individual responsibility and more enthusiastic to tackle the job than when he left it. This can best be done by each one feeling that this is his convention and that he must faithfully attend all the sessions, absorb the best ideas advanced by others, contribute freely from his own experience, and carefully study the exhibits.

During the last nine months the railroads have handled the largest volume of business ever before offered during a similar period, and it is certain the peak will not be reached before October. Our work is already mapped out for us and it is none other than to see that this volume of business is handled with the minimum consumption of fuel.

The report of the secretary-treasurer, J. G. Crawford, gave the membership at the end of 1922 as 976 and showed a balance on hand of $500, with all bills paid.

The association was also addressed by T. K. Maher, president, The Maher Collieries Company, Cleveland, Ohio, and H. M. Griggs, manager, Ore and Coal Exchange, Cleveland, Ohio. Mr. Griggs outlined the work of the exchange, which serves as a clearing house of advance information relative to the exchange of lake and rail traffic in coal and ore, and presented data showing a volume of lake and rail movements through Lake Erie ports during the seven months' navigation season, that requires the dumping of an average of 3,000 cars of coal daily and 5,000 empty cars a day for ore loading.

In two papers, one presented by R. S. Twogood (Southern Pacific) and the other by Professor R. W. Noland (Purdue University), a new field for the development of fuel economy was opened up. The first dealt with the handling of small power plants and the second with economy in the heating of stations and buildings. The association authorized the appointment of a committee to take up the study of this phase of railway fuel consumption, co-operating with the American Society of Mechanical Engineers in the development of a practicable test code for use at small power plants.

The following officers were elected for the next year: President, M. A. Daly (Northern Pacific); vice-presidents, J. W. Dodge (Illinois Central), P. E. Bast (Delaware & Hudson) and J. R. Evans (Chesapeake & Ohio). The new members of the executive committee are: J. E. Davenport (New York Central), H. T. Bentley (Chicago & North Western), E. E. Chapman (Atchison, Topeka & Santa Fe), C. H. Dyson (Baltimore & Ohio) and W. J. Tapp (Denver & Rio Grande Western). J. B. Hutchinson (Pennsylvania) is secretary-treasurer.

J. N. Clark (Southern Pacific), President

M. A. Daly (Northern Pacific), Vice-President

J. W. Dodge (Illinois Central), Vice-President

P. E. Bast (Delaware & Hudson), Vice-President

An abstract of the report on feedwater heaters is given below. Other papers and reports will be abstracted in later issues.

Report on Boiler Feedwater Heaters

The first part of the report outlined the development and history of feedwater heaters and summarized the various reports on the subject that have been presented to the association since the initial report in 1914.

A very complete questionnaire was sent out by this year's committee and the results of the answers from 18 roads were embodied in tabulated form.

Present Equipment—America

The replies to the questionnaire show the popularity of

the feedwater heater to be increasing steadily, and some roads state that all new power will be equipped with the device. One road says that it eventually expects to have every locomotive having cylinders 20 in. in diameter or over equipped with feedwater heaters.

Some state that they see little increase in capacity of heater-equipped power, but the majority point out that the increased capacity is dissipated in increased speed. It has been found that engineers who are accustomed to working their locomotives by sound run with a longer cut-off due to some of the exhaust being taken by the heater, thus reducing the sound and causing the engineer to think he was not getting the same amount of work out of the locomotive. This, of course, counteracts some of the saving effected by the heater, but longer experience and greater familiarity will naturally overcome such conditions.

It has been found in some cases, either due to working the locomotive harder or the presence of oil in the water, that on long runs the locomotive equipped with the feedwater heater has a tendency to foam badly toward the end of the run. It was naturally expected that with less water being drawn from outside sources the reverse would be true.

One road has eliminated the oil separator and has made a feedwater heater of 5,400 gallons capacity the standard, with the view that the maximum capacity of the locomotive is required so seldom that the injector should take care of the short periods which the larger locomotives are worked beyond the capacity of their heater.

A check of locomotives built since March 1, 1922, and now on order, brings out the interesting fact that practically one-third of the whole number are equipped with feedwater heaters. Of the 1,724 heaters ordered since 1920, 1,429 were ordered during the year ending May 1, 1923.

Two roads are reported to have been trying heaters not so widely known, one, a waste gas type, known as the Foster-Thompson heater, and the other a locally designed waste steam type known as the Skinner feedwater heater. Both roads report that they have no test data or performance that can be published at this time.

Present Equipment—Foreign

The past year has brought to light several interesting developments in locomotive feedwater heating abroad. What is probably the most practical form of gas type heater so far constructed, was recently applied to a locomotive of the Austrian Federal Railways. This is the invention of J. Rihosek, mechanical engineer, Vienna, and is designed so that it may be removed from the smoke box and replaced as a unit and thus conveniently cleaned inside and outside.

In an article recently contributed to a foreign publication, the author states that tests of this heater have supplied valuable data regarding the amount of heat that can thus be reclaimed from the waste gases.

Rihosek, however, calls attention to the fact that heaters of the exhaust steam and waste gas type may be combined in series whenever the weight of the locomotive permits such an arrangement. In this case, it is stated that cold water from the tender would first be heated by exhaust steam to a temperature of about 190 deg. F. and subsequently, in a waste gas heater to temperatures ranging from 265 to 300 deg. F. It is pointed out, moreover, that the added economy resulting from elevating the feedwater to temperatures considerably above that of exhaust steam is not the only advantage of this arrangement since the boiler scale forming impurities will be partly deposited in the heater, owing to the higher temperatures in the second stage of the apparatus.

Another significant development is the introduction of the open type of heater abroad. In place of the Knorr apparatus which has been exclusively used in Germany, Austria and Hungary, a pump of the Worthington type has recently been adopted for new motive power on the Hungarian State Railways. It would appear from the illustrations of this equipment, however, that after being discharged from the open type heater, the feedwater is passed through a closed type heater before entering the boiler. The open type apparatus used on these locomotives is manufactured in Budapest. This is positioned on the left side of the locomotive and the closed type heater which is used in series, comprises a drum located underneath the smoke box. The locomotives to which this equipment is applied are also provided with feedwater purifiers of the Pecz-Rejto type mounted on top of the boiler barrel.

Since the effect of feedwater heating is to increase the rate of evaporation in the boiler, it follows that any tendency toward foaming occasioned by chemical impurities in the water will be enhanced by feedwater heating. Water purifiers are already being tried in some foreign countries and it is believed that their possibilities are such that investigation should be made and reported to the association. It is suggested, therefore, that the subject of water purification by means of apparatus supplementary to the feedwater heater might properly be studied by your committee during the coming year, since it appears that the possibilities of this means of water purification have never been fully investigated.

The Exhaust Steam Injector

The exhaust steam injector, which the committee has been requested to investigate, is yet in its development stage in this country. From the information available, it seems that there is not quite as great a range with the exhaust steam injector as with the live steam injector. The range is, however, sufficiently great to meet the requirements of the average service of American locomotives. This device is extensively used in Europe, there being at this time in the neighborhood of 6,000 exhaust steam injectors actually in service.

A report from an English road states that they have 515 exhaust injectors of the Davies and Metcalfe type, operating in both passenger and freight service. The locomotives and trains are not as heavy, however, as the general average in this country, but since the performance of the device is considered quite satisfactory it seems reasonable to expect that improvements will shortly be made which will render it adaptable to heavier service. The particular road mentioned states that all new power purchased is being equipped with exhaust steam injectors.

The type of oil separator used with the Davies and Metcalfe exhaust steam injector is the same as that used on the Elesco in this country.

It is difficult to calculate accurately the coal and water saving of the exhaust steam injector, because these vary largely with the amount of water delivered. Under conditions of high back pressure, such as are met with when the engine is working at maximum capacity, the exhaust injector will feed the boiler without the use of any live steam whatever. When the engine is working at low rating, the live steam used runs up as high as 2½ per cent of the weight of water delivered to the boiler.

The temperature of the water delivered to the boiler is highest when the injector is working at its minimum rating, but the heat recovery is greatest when the injector is working at maximum capacity.

Tests made in this country have shown coal savings around 10 per cent to 15 per cent. The best results, of course, are obtained when the exhaust injector is kept continually at work from one end of the line to the other. Starting and stopping the injector not only results in the loss of some water in priming, but no exhaust steam is saved when the injector is not working.

Summary

A summary of trials and experiments of various roads with various kinds of feedwater heaters brings out the following basic principles which should govern heaters as applied to locomotives in order to realize their full benefit:

1. The boiler feedwater shall be heated from a source of heat that would otherwise have been wasted.

2. The apparatus shall present the greatest possible simplicity of construction with the smallest possible number of wearing parts. It shall occupy as little space as possible and be of the minimum weight.

3. The feedwater heaters should give a continuous and certain supply of hot water, the temperature of which will increase with an increase of the pressure of the exhaust steam or the temperature of the front end gases.

4. Arrangements shall be provided for separating any lubricating oil from either the steam or the water of condensation and the lubricating oil allowed to enter the boiler shall be reduced to a minimum.

5. Hot gas heaters or economizers should be arranged to present the minimum interference with the passage of the gases from the boiler flues to the stack, and should also be so constructed as to be quickly and easily removed and replaced. They should have the minimum of separable joints within the front end.

The members of the committee were E. E. Chapman (A. T. & S. F.), chairman; E. A. Averill (Superheater Company); H. A. Macbeth (N. Y. C. & St. L.); J. A. Carney (C. B. & Q.); Geo. S. Mikles (N. Y. O. & W.); G. N. Gresley (London & North Eastern); Geo. E. Murray (G. T.); J. M. Lammedee (Worthington Pump & Machinery Corp.); L. G. Plant (Railway Review); W. A. Larick (N. Y. C.); Prof. J. M. Snodgrass (University of Illinois); L. P. Michael (C. & N. W.), and G. Von Boden (S. P.).

Discussion

H. B. Oatley (Superheater Company) presented a written discussion in which he estimated a fuel saving of $1,000 a year for the feedwater heater on the basis of a locomotive burning $10,000 worth of coal a year. From this should be deducted $150 for investment charges. The only debatable question, he stated, is how much of the remaining $850 will be required for additional maintenance. The only solution of this question is experience based on a large enough number of heaters in service at one place to permit this work to be regularly organized. He stated that variations in local conditions were such that the experience of one road would not answer the question for another.

The only case cited in which maintenance has been excessive was on the Central Vermont, where, in spite of the fuel saving effected, the heaters have been removed because of excessive terminal attention. E. A. Averill (Superheater Company) gave the results of a study of work reports on 334 arrivals of feedwater heater locomotives over a period of one month at one terminal, after the heaters had been in use from five to six months. Eighty per cent of the work reports contained no reference to the heaters, 95 per cent showed no work that would require over 15 min., and the remaining five per cent called for inspection or work of indeterminate amount. The record was perfect as to failures chargeable to the feedwater heaters.

On the Southern Pacific some trouble has been experienced from hot water leaking into the low pressure pump cylinder when the heater is not working, thus causing the suction to break when the heater is started. To avoid this trouble it has been found best to start the heater pump at the same time as, or a little before the locomotive, and to work it continuously while the locomotive is working. Engines with feedwater heaters on the Southern Pacific have been found to steam so freely that the exhaust nozzles have been increased in size.

Air Brake Association Meets in Denver

To Develop Tolerances for Triple Repairs; Discuss System of Central Repair of Engine Brakes

A REPRESENTATIVE gathering of air brake supervisors and foremen from all sections of the United States and Canada were in attendance at the thirtieth annual convention of the Air Brake Association. The meeting was held at the Albany Hotel, Denver, Col., on May 1, 2 and 3 and was exceptionally well attended by representatives of the western roads.

The opening session called to order by the president, Mark Purcell, Northern Pacific, was given over to a number of addresses and business reports. W. R. Scott, president of the Southern Pacific, Texas and Louisiana Lines, gave some of the early history of the air brake and told how when he was a member of the Traveling Engineers' Association the air brake discussions early demonstrated the need for a separate organization to devote its entire time to air brake subjects. He paid a tribute to the fertility of invention and the energy of the men who have been instrumental in the development of the air brake, citing a case in which the Westinghouse Air Brake Company had furnished enough empty and load brakes to equip several trains in six weeks after the need for such a brake had been suggested to the officers of the company as a means of facilitating operation

Mark Purcell (Northern Pacific)
President

George H. Wood (A. T. & S. F.)
1st Vice-President

C. M. Kidd (N. & W.)
2nd Vice-President

F. M. Nellis (Westinghouse Air Brake Co.) Secretary

of trains on the mountain grades of the Southern Pacific.

In speaking of the future of the association, Mr. Scott said that its opportunities for useful service were as great as they have been in the past. One of the things demanding its attention in the future, he said, was the relation of automatic train control to brake operation. The co-ordination of the operation of the train control system with that of the brake system and signal system under the wide variety of conditions encountered on American railroads, he said, presented a phase of the subject not covered by the limited installations so far made and introduced air brake men to a new phase of railway operation. He also expressed the belief that the further development of the light and load brake should be taken up.

Mr. Scott said that he had learned that many of the members in attendance had come on their own time and at their own expense. This he said should not be. The cost to the roads of sending men to the convention he considered infinitely small compared with the value of the work of the association, and he suggested that if the association approached the individual executives, they could be made to see that it would pay them to send their men.

Mr. Scott referred briefly to the program of the executives to provide adequate service to the American people during the current year and said that it had been suggested that he tell the association what it could do to help in carrying out this program. This he said was attacking the problem from the wrong end; the air brake men should tell the executives what measures should be adopted in their field and should formulate their own part in the program.

President Purcell's Address

President Purcell in his address said: "To a large extent the state of economy and efficiency reached in railway transportation in its present stage is due to brake control. Without such control, the number of trains that could be handled over a district in a given time would be very much less because the trains would have to be spaced farther apart and the speed restricted to prevent accidents.

The maintenance and operation of brakes is one of the most important departments of railway operation. The best methods of organized inspection and repairs are time-savers in getting trains over the road and through terminals. Air brake men are best qualified to recommend what practices should be followed and now that a greater shortage of equipment is threatened than was ever experienced before in the history of the railroads, there is an opportunity for the air brake men of the country to be of great assistance to the roads in getting the most service out of the equipment available by facilitating more rapid movement of cars and increased mileage with less time on the repair tracks.

"The Air Brake Association has acquired a degree of authority such that it is being consulted with respect to brake matters and train operation more than in the past. This points to the need of exercising the greatest care when recommending or endorsing measures that action be not too hasty, but that they be carefully investigated and fully discussed in all their bearings before action is taken."

S. G. Down Compares American Railways and Those in Foreign Countries

S. G. Down, vice-president of the Westinghouse Air Brake Company, who has during the past few years observed railroad performance in most civilized countries, said that none of the government controlled roads with which he has come in contact can compare in efficiency with American railroads. Those who are so ready to attack railway management in this country, he said, ought to have to get along with the transportation conditions prevailing where the roads are operated by the governments.

One of the great advantages of the railroads in North America as compared with continental Europe is the universal interchange of equipment. In Europe, he said, one of the greatest difficulties in the way of interchange is the number of types of brake equipment employed in the different countries which will not operate synchronously with each other. He stated that in North America there is an investment of five hundred million dollars in brake equipment, all of which operates interchangeably. The magnitude of this investment he cited to show the importance of keeping on firm ground as to fundamentals and not introducing any changes that will interfere with the universal interchange of cars.

The following papers were read and discussed:

Expediting Train Movement, by the North-West Air Brake Club; Charging Freight Trains and the Use of Release Position, by W. F. Peck (Baltimore & Ohio); Causes for Slow Operation of Locomotive Air Compressors, by the Pittsburgh Air Brake Club; Feed Valve Tests, by the Manhattan Air Brake Club, and two papers on the 8½-in. cross compound compressor, one by the Central Air Brake Club and one by the Dixie Air Brake Club. George H. Wood (Atchison, Topeka & Santa Fe), in a brief talk also discussed the relation of train control to the air brake.

Expediting Train Movement

By The North-West Air Brake Club

The following is an abstract of a paper presented for the North-West Air Brake Club, by H. G. Clark (M., St. Paul & S. S. M.):

In his address before this convention W. R. Scott, president of the Southern Pacific Lines, called attention to the impending transportation crisis and stated that among other measures to meet the situation, it is proposed to reduce the bad order cars from the present 9 per cent to 5 per cent, the freight locomotives awaiting heavy repairs from about 21 per cent to 15 per cent, and to increase the car mileage to 30 per day. That strenuous efforts in 1920 were able to raise the car mileage to only about 25 per day, and that the car loading is expected to exceed by from 7 to 15 per cent the peak of 1920, will indicate the task before us.

In his efforts toward maintenance, the air brake man must not lose sight of the fact that the air brakes are merely one important means toward the end of moving traffic. A train or even a car held for brake testing or repairing only, where such work could in part or in whole have been done during a necessary delay for some other work is an inexcusable interference with traffic movement. To the extent that the air brake man keeps this in mind, informs himself of the operating department's plans for expeditious freight train movement and submits plans for testing and repairing that will utilize dead time to the best advantage and cut necessary delays for such work to the minimum, will he realize his opportunities.

But the inauguration of good plans will accomplish little. They must be followed up patiently and persistently. There must also be a general co-operation by all railways, not leaving the burden largely to those with steep grades, as has been done too generally. A chain is no stronger than its weakest link; if mountain roads must make the heaviest repairs the traffic of the entire country will be materially slowed and endangered.

The thing to strive for is to have the air brakes in such condition when the outgoing engine is coupled to the train that all that will be required is a formal test to insure that the brake condition is as intended, followed by an immediate release.

As no one can argue against the desirability of this and as it cannot be even remotely approached if the outgoing test is awaited to disclose any defective brakes, it is plain that with-

out the incoming brake test no worth-while effort has been made to meet the great needs of the times.

It is not enough merely to get an order issued that the incoming test shall be made. Some of the first difficulties such an order runs into are:

(a) A delay because the engineman felt it necessary to recharge before applying for the test. This tends toward an incomplete recharge and a poor test.

(b) The brakeman closes the angle cock on the tender before the test application is completed, thus destroying the test except by a delay to thoroughly recharge and then apply.

(c) If the train is to be put on two tracks, it is felt that the test application cannot be made. This is not so.

(d) A switchman opens an angle cock soon after the test application is made, thus increasing the rate of brake cylinder leakage and spoiling the test.

(e) If the incoming crew see no car men present they decide that no test application is necessary. The test application should be made invariably.

(f) Uninstructed switchmen bleed off good brakes before they are inspected, thus causing such brakes to be bad ordered.

(g) The air brake inspection is combined with the general inspection, thus taking so much time to complete that effective brakes are condemned for leaking off. The air brake inspection should be completed within 20 minutes after the test application is made.

(h) The engineman fails to insure a full 20-lb. service reduction for the test, often making no more than was required for the stop, instead of adding to this enough to make the total reduction a full 20 lbs.

If full advantage of necessary delays is to be taken to do air brake work, then all cars on repair tracks must have their brakes so tested as to disclose their actual condition, all must be repaired that are not efficient, irrespective of stencil dates, and all must be cleaned where the stencil date is nine months old or more. Full advantage also must be taken to inspect the repair brakes, as well as other practicable parts, on cars "parked" at transfer and freight sheds, and team tracks where the number per day will justify. Motor driven compressors requiring no care other than occasional inspection and oiling, and pipes laid on the ground will often permit of quickly preparing to do such work. At what time is it more important to have a freight car ready to proceed than right after it is loaded? And when is there a better time to prepare a car for being loaded than when it is being emptied?

Monthly brake cleaning reports, identifying the cars and the previous cleaning stencils, with all cases where the brakes were found ineffective within four months after cleaning tabulated by home road cleaning points, will make it possible to stop inefficient cleaning.

To have high ideals to strive for is well worth while, but to insist that ideals be attained when existing conditions are far from ideal will obtain far less results than to stipulate merely a moderate improvement. In fact, emergencies occasionally justify practices deviating from the standard. More brakes can be cared for if the brake cylinder pistons are cleaned under the car and replaced than if taken to a room. To say that the work cannot be done efficiently under the car is to ignore that many roads with the best average brake maintenance do this.

Referring to such an emergency as evidently impends, and with the distinct understanding that this suggestion does not apply otherwise, if at some transfer or freight sheds where many cars are available per day it is impossible to get an air supply, at least for some time, why not locate and indicate the ineffective brakes by an incoming test just before the cars go to such points, and then clean the brake cylinders and replace the triple valves with others that have been cleaned and passed over the test rack? This will not only effect a big improvement with no car delay, but if well instructed and reliable men are assigned to the work it is confidently believed that the results will well justify the temporary deviation from correct practice until compressed air can be supplied.

Even if you have a train yard test plant why not have the test application made on the incoming trains by the enginemen and save time for the train and the car men instead of coupling to the yard plant, charging and applying the brakes? The need for having the inspectors present when the trains stop will reduce the dead time for trains.

Furthermore, it is easily possible by casual and quick inspection, a twist on each angle cock and retaining valve pipe (the latter while changing the triple valve or by vibrating it when no change is necessary) and by a pull with a wrench on any unions, to very materially reduce pipe leakage without any air pressure for testing. On one mountain grade subject to interchange traffic, unsatisfactory retaining valve efficiency was very materially improved by having the train inspectors at the previous terminal shake each retaining valve pipe and tighten joints that this disclosed to be loose.

Other possible and valuable improvements with no air for testing are turning angle cocks and hose to proper position, tightening loose brake cylinders, auxiliary reservoirs and pipes, locating and replacing missing cotters, replacing worn-out brake shoes, etc., as well as repairing defects of other than the brake parts.

The will to do all that we can and earnestly looking for them will disclose remarkable opportunities for improvement without car or train delays, often with no more men, and, in many particulars, even without air for testing.

Discussion

The discussion of this paper dealt very largely with the advantages of the incoming brake test and the difficulties generally encountered in making it effective. Some of the members advocated the release of the brakes after the train had been brought to a full stop in the yard in order that the slack might be stretched before making the 20-lb. test reduction. This, however, was not generally favored by the members who took part in the discussion because of the additional time required and, therefore, the greater difficulty of getting the co-operation of the incoming crews and the yardmaster to make the test effective. It was suggested by several of the members that yardmasters are responsible for the greatest opposition to the effective performance of the incoming test because of their hurry to break up the train. Some of this objection can be overcome by permitting them to close the angle cock between cuts of five to ten cars behind the inspector, so that the brakes on the cars already inspected can be bled off.

There was no dissent in the discussion to the opinion that the incoming brake test is a most effective means of reducing terminal delays and effecting promptness in the dispatching of trains through the utilization of terminal time for the making of air brake repairs rather than trying to do the work after the train is made up and ready to depart from the yard. The extent to which the test is effective depends on the determination of the responsible officers to make it effective, and not on any inherent conditions that may be imposed by the test itself.

Closing Business

The following officers were elected for the next year: President, George H. Wood, A. T. & S. F.; first vice-president, C. M. Kidd, N. & W.; second vice-president, R. D. Burns, Penna.; third vice-president, M. S. Belk, Sou. The following are the members of the Executive Committee: H. L. Sandhas, C. R. R. of N. J.; H. A. Clark, M. St. P. & S. S. M.; W. W. White, M. C.; J. J. Flynn, D. & H., and William H. Clegg, C. N.

Annual Convention of the Master Boiler Makers

PRELIMINARY registration of the fourteenth annual convention of the Master Boiler Makers' Association, held at the Hotel Tuller, Detroit, Mich., on May 22 to 25 incl., indicated a record attendance. About 300 members of the association, 125 representatives of the Boiler Makers' Supply Men's Association and many guests were present.

The meeting was called to order at 10.15 a. m. by Thomas Lewis, general boiler inspector of the Lehigh Valley at Sayre, Pa., and president of the association. After the invocation, J. C. McCabe, general boiler inspector of the State of Michigan, acting for the mayor of Detroit, was introduced. He reviewed briefly the promotion of safety in boiler requirements in the State of Michigan, giving credit to the builders of locomotive boilers for the part their methods have played in building better boilers and to the members of the association in properly maintaining them. The standards of construction and material used in locomotive work have aided the American Society of Mechanical Engineers materially in developing the standards of sections of the Boiler Code. The great value of the work of the association is shown in the comparatively few accidents that occur.

President Lewis, in his annual address, pointed out the annual meeting fulfilled two functions—that of giving men interested in boiler work the opportunity to meet others whose life work was the maintenance of boilers and of providing a clearing house for ideas that would be helpful to all. During the past year the master boiler makers of the country have played a more important part than ever before in keeping the motive power of the railroads in condition. The future indicates that the boiler makers will be under even a greater strain to meet requirements made upon them. Locomotive boilers must be maintained to as nearly perfect efficiency as possible if the roads are to meet increased traffic demands. It has been said that 97 per cent of the efficiency of a locomotive depends on its boiler. The present emergency will not permit the practical boiler maker foreman to be ignored and his value is being more fully realized by the mechanical department officers of the railroads every day. He concluded with the advice to the younger members of the trade present that work and education were necessary to their advancement and that full advantage be taken by them of the educational possibilities available through the papers and discussions.

The remainder of the opening session was occupied with the secretary's and the treasurer's reports, which indicated that the membership is about 400, with almost 200 delinquent members in addition, and the association is financially sound.

On Wednesday committee reports were given on the following subjects: Hammer Testing of Staybolts on Our Modern Locomotive Boilers Is Now One of the Most Important Duties of Local Boiler Inspectors, J. A. Holder, chairman; Are the New Combustion Chamber Boilers as Easy to Maintain as the Straight Standard Firebox? Henry J. Raps, chairman; The Finished Material (Boiler Plates) Should Be Sound and Free from Cracks, Surface Flaws and Laminations, and No Hammer Dressing, Patching, Burning or Electric Welding Is Allowed, Charles P. Patrick, chairman; Is the Use of Automatic Stokers on Locomotive Engines Injurious to the Firebox Sheets? Do the Firebox Sheets Crack More Readily in a Stoker-fired Engine than in a Hand-fired Locomotive? H. A. Bell, chairman; What Are the Best Methods of Detecting Defective Boiler Sheets in the Shop Before going to the Laying Out Bench and Put into Service? John J. Keogh, chairman.

The remaining sessions were devoted to committee reports, discussions, and the election of officers, as indicated in the following: What Is the Standard Method of Applying Flues in Locomotive Boilers, Also in Stationary Boilers? Albert F. Stiglmeier, chairman; The Life of the Superheater Tube and the Number of Safe-ends That Should Be Applied Before They Are Cut Down for a Smaller Boiler, J. P. Malley, chairman; To Report Topics for 1924 Convention, John F. Raps, chairman; Care of Water Tube Stationary Boilers, J. J. Davey, chairman. Addresses: Steam Leaks and the Bad Effects on the Boiler Plate, D. A. Lucas, chairman; What Experience Has Been Had in Connection with the Electric Weld Heater, John W. Hoyt, chairman; Report of Committee on Rules for Recommended Practice and Standards, Leonard C. Ruber, chairman; Reports of Committees; Election.

The following officers were elected for the next year: President, E. W. Young, mechanical assistant to the general superintendent motive power, C. M. & St. P., first vice-president, Frank Gray, tank foreman, C. & A.; second vice-president, Thomas F. Powers, assistant general foreman, boiler department, C. & N. W.; third vice-president, John F. Raps, general boiler inspector, Illinois Central; fourth vice-president, W. J. Murphy, general foreman boilermakers, Pennsylvania Lines West; fifth vice-president, L. M. Stewart, general boiler inspector, Atlantic Coast Lines; secretary, H. D. Vought, 26 Cortlandt street, New York; treasurer, W. H. Laughridge, general foreman boilermaker, Hocking Valley. Executive board, three years: E. J. Reardon, district inspector locomotive boilers, I. C. C.; Henry J. Raps, general boiler foreman, I. C.; J. Nicholson, foreman boilermaker, C. & N. W. Executive board, two years: Jeromia Hart, foreman boilermaker, C. B. & Q.; K. E. Fogarty, general boiler inspector, C. B. & O.; John Harthill, general foreman boilermaker, New York Central. Executive board, one year: Henry J. Wandberg, traveling boiler inspector, C. M. & St. P.; George Austin, general boiler inspector, A. T. & S. F.; C. H. Browning, foreman boilermaker, Grand Trunk. Chairman of the executive board, E. J. Reardon; secretary, H. J. Raps.

Thomas Lewis, Retiring President

E. W. Young, President

Frank Gray, 1st Vice-President

W. H. Laughridge, Treasurer

New

And Improved

Machine Tools

And

Shop Equipment

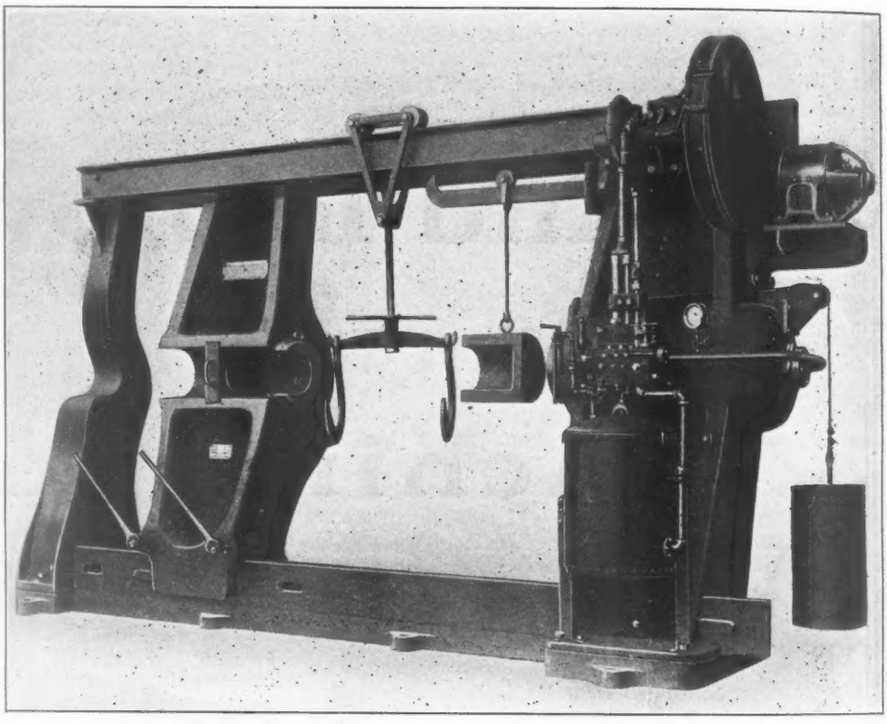
Hydro-Pneumatic Convertible Wheel Press

THE hydro-pneumatic wheel press illustrated has been designed by the Chambersburg Engineering Company, Chambersburg, Pa., so that it can be easily converted from a vertical to an inclined type press or vice versa. It is therefore, adapted for use in connection with either an overhead traveling crane, or lifting hooks carried by a trolley running on a removable I-beam supported on the press. In the illustration the machine is arranged as a vertical press with the lifting hooks in position. When the I-beam which carries the trolley for the lifting hooks is removed, the machine is transformed into an inclined type press, allowing chains or cables of an overhead crane to clear the upper tie bar when handling wheels and axles in and out of the machine.

Provision is made in this design for an extra rapid movement of the press ram out against the work by means of compressed air. A heavy counterweight is used for the pull-back, being connected to the ram with a wire rope running over a turned sheave, thus assuring rapid return of the ram.

The pump is made from a solid steel forging, and is of the triplex, single-acting type, driven by a shaft well supported in double bearings. All valves in the pump are made of monel metal. Trip levers control the movement and speed of the press ram without stopping the pump or motor. If desired, the ram can be held against the work under full tonnage indefinitely. The levers for operating the press are conveniently located and are easily and quickly operated in a natural rotation.

The machine is practically of all steel construction, the main castings being made of carefully annealed open hearth steel of a special analysis. The cylinder is copper lined, truly bored and burnished. The ram is made of close grained charcoal iron and is turned and finished with a rolling process, thereby giving it a surface which resists the corroding action of water and keeps it in a smooth and polished condition. The inside end of the ram is provided with a cup leather of improved design, arranged with a spring ring to prevent the collapse of the leather and loss of water when the ram is returning. The resistance beam is carried by turned rollers on planed ways. It is provided with a removable top and a removable yoke. The opening in the resistance beam is sufficiently large to admit the largest diameter axles easily. A jib crane is attached to the cylinder beam, to carry the ram distance piece, which permits it to be swung out of the way when not in use. The tie bars are steel forgings, arranged with machined stops at suitable distances apart to accommodate standard M. C. B. axles. There is provided on the press a large pressure gage, graduated to show tons pressure on the ram and also pounds pressure per sq. in. Also a safety valve is provided on the pump to prevent overloading the press. A rear guard completely covers the gearing. This machine has a massive plate and it can be bolted directly to the concrete foundation.



Chambersburg Hydraulic Wheel Press Arranged to be Used as Vertical Type

Simple design, durable construction and ease of operation are features of the wheel press illustrated. It can be used for mounting one or both wheels simultaneously, and demounting one wheel at one pressing. It is made in sizes ranging from 34 in. to 120 in. between the tie bars, and from 100 to 1,000-ton capacity.

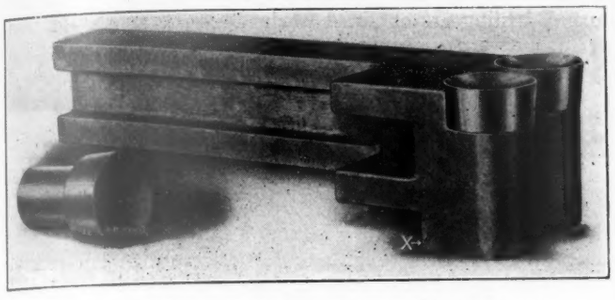
Special Toolholder for Turning Tires

FOR turning locomotive and car wheel tires, Sir W. G. Armstrong, Whitworth & Company, Ltd., London, S. W. 1, England, has developed the interesting special toolholder with circular cutters illustrated. This toolholder was developed in an effort to eliminate the necessity of chipping and grinding the hard places in tires. It was also desired to turn the hardest tire without removing more metal than necessary to bring the tire back to its true form.

Normally, two cutters are inserted in one holder, and when turning, one cutter is presented to the work at the edge of the tread, the other cutter being presented in the center of the tread; thus each tool has to traverse only one-half of the width of the tire. The last named cutter being presented to the middle of the tread, where the tire is usually hardest, has a better chance of standing up to the work by virtue of the fact that it is cool and the edge has not been dulled by traversing the first portion of the tread before reaching the hard place.

The radius of the cutters is equal to the radius of the tire at the point where the tread joins the flange. Thus, by the

use of a simple gage, the radius can be formed by the roughing tool. The cutters are made of Super Tyr steel which is



Armstrong-Whitworth Toolholder With Circular Cutters

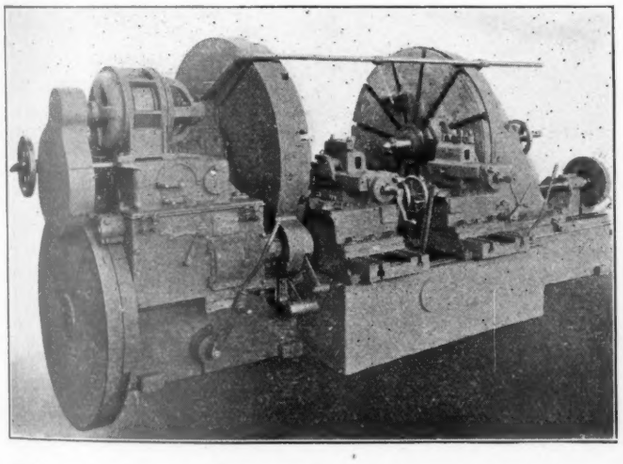
hardened in water and has the necessary qualities to turn the hard places in tires.

The cutters themselves are inserted in the holder without keys or screws and therefore when turning exceptionally hard places, it is a simple matter to withdraw the rest and turn the cutter slightly bringing a new cutting edge up to the work. The top of the cutter is ground slightly concave to give the necessary top rake, this rake varying according to the hardness of the tires. By means of a simple fixture on an ordinary surface grinding machine, these cutters can be reground in a few minutes. All the grinding takes place from the top, and as the cutter is ground down, thickness rings are inserted beneath the shoulder in order to maintain the correct height on the cutting edge. By this means the cutter is ensured a long life. In fact two of these cutters have double the life of an ordinary round nose roughing tool. At the same time the holder is a permanent item of equipment. The abutment *X*, in conjunction with a mark on the rest, will assist in resetting tools in the same position.

This arrangement is said to have been thoroughly tested with the hardest tires with complete success.

Eighty-Inch Standard Driving Wheel Lathe

THE wheel lathe illustrated has been placed on the market by the Putnam Machine Works of Manning, Maxwell & Moore, New York, to handle driving wheels with 28 in. to 75 in. diameter treads, as a considerable number of railroad shops are never called upon to turn wheels above this diameter. Convenience of operation is a special feature, and by a unique arrangement in which a clutch is used to drive the faceplate through the feed pinion,



Putnam 80-in. Wheel Lathe Driven by A. C. Constant Speed Motor

six additional faceplate speeds are obtained for journal turning.

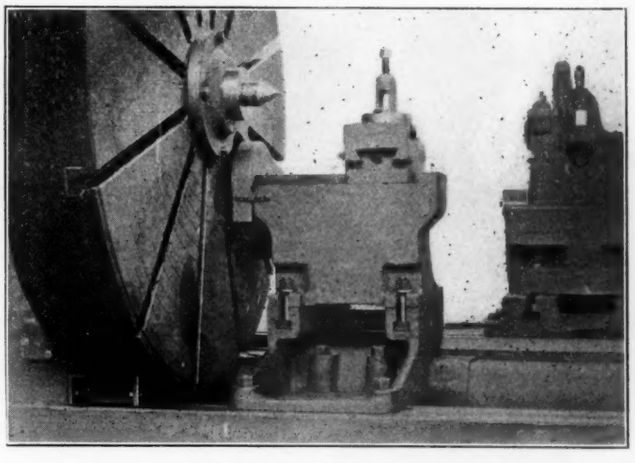
Each faceplate is equipped with four improved Putnam adjustable equalizing driving dogs. The tailstock has power traverse by an individual motor; a friction clutch allows the motor to be started under no load, and an automatic trip throws the clutch out when the tailstock has run back far enough to take the wheels out of the machine. This trip is adjustable for different lengths of axles.

The tailstock is clamped by two large bolts on front and two on the rear which engage T-slots in the bed. These bolts are set up by two wedges actuated by a right and left-hand screw, equalizing the strain on each bolt and quickly and firmly clamping the tailstock to the bed. This device is operated from either the front or the rear of the machine with a ratchet wrench.

The tool rests have in and out adjustment on the bed sufficient to turn wheels from 28 in. to 75 in. tread diameter. The tool slides have in and out adjustment and longitudinal power feed. The slide bases have hardened and ground steel plates on the surfaces where longitudinal tool slides bear. Combination tool blocks reduce the number of operations to a minimum. Each tool slide has one roughing tool and forming blades mounted side by side, each independently detachable for regrinding. A set of forming blades is furnished with each machine.

The feeding mechanism gives several impulses per revolution and is practically continuous. The feed ratchets operate in either direction and are of the enclosed type. A calipering attachment is furnished as regular equipment. Suitable telescoping sheet iron guards extend between the faceplates entirely covering and protecting the working parts from chips and scale.

When so desired the machine is equipped with single or



Outside Journal Turning Attachment

double quartering attachments with capacity for quartering wheels of locomotives with 24 in. to 36 in. stroke.

Either inside or outside journal-turning attachments or both can be supplied when wanted; there is power feed to both these attachments. With the inside attachment both journals can be turned simultaneously and finished from hub to hub if necessary. There is a power cross feed for facing hub liners.

The lathe can be furnished with power cross feed for facing the sides of tires and can also be arranged for boring tires. It is so designed that it may be readily arranged to handle narrow or broad gage wheels.

The drive can be either by single pulley belt, 30 hp. constant speed motor, or 30 hp. adjustable speed direct current motor. Faceplate speeds of .5-.7-.9-1.1-1.5 and 1.9 r.p.m. for tire turning and 4.4-6-7.6-9-12.6 and 16 r.p.m. for journal turning are obtained while ⅛-¼-⅜ and ½-in. feed per revolution are provided.

Locomotive Frame Slotting Machine

An innovation in the design of locomotive frame slotting machines has recently been produced by the Niles-Bement-Pond Company, New York. The principal departure from conventional practice lies in the method used for the main drive of each unit. The former method of securing the reversing motion was by means of the familiar crank and connecting rod or through the use of reversing pulleys and belts for transmitting power to a rack on cutter bar. The new design utilizes a reversing motor mounted on each head which, driving through one pair of gears only, rotates a vertical screw that directly engages the cutter bar.

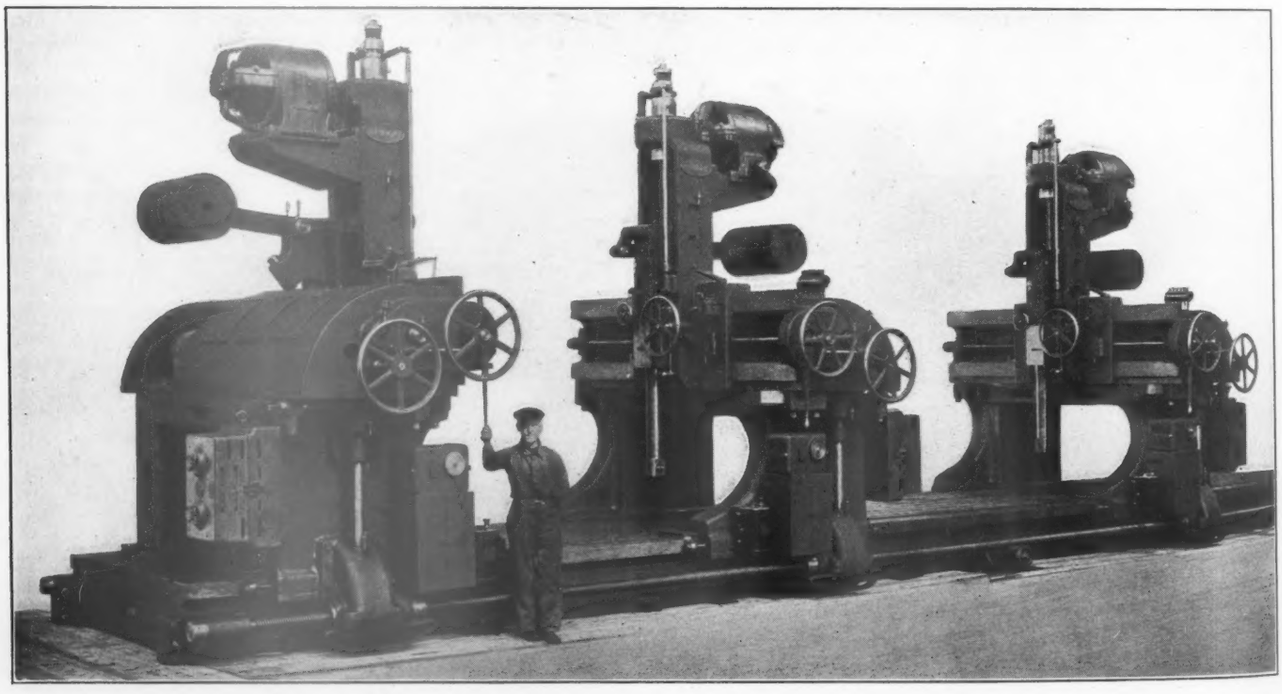
The motors are 20 hp. each, with a 4 to 1 speed range. The cutting and return speeds are controlled independently, and any combination between them can be obtained within the speed ranges of the motor. The return speed range limits are naturally much higher than those assigned to cutting. Two dials on the contactor panel are connected with the rheostats which govern these two-speed functions. The desired cutting speed is set on one, the return speed on the others. The motor is reversed by automatic contactors governed by a pilot switch, actuated by the tripping of adjustable dogs on the cutter bar. The dogs are set by hand at locations that give the desired length and location of stroke. The maximum stroke is 38 in.

Another novel feature of the machine is found in the feed arrangements employed. Each head has its own motor for feeding and traversing the head along bed and the saddle along crossrail. This motor through gears and shafts engages with and revolves nuts on fixed screws along each side of the bed for the longitudinal feed and traverse of the head. The same motor is used for feeding and traversing the saddle along the crossrail through another gear train. The control and operation of both feed and traverse is electrical. A dial set at the desired feed point allows the feed motor to make one or more revolutions intermittently by means of which the desired feed is obtained. Throwing a switch allows the motor to run continuously, giving fast traverse of either head or saddle as desired.

Slotting at an angle too steep to be covered by the swiveling feature of the crossrails is necessary at the ends of some locomotive frames, and this requirement is met in this machine by combining long and cross-feeds for simultaneous action. By change gears and swing arms, combinations between these feeds may be effected to slot any angle up to 45 degrees.

These machines are built with from one to three heads and in any desired length of bed. The machine illustrated has a bed length of 60 ft. Each head is self-contained and independent in every way. The head comprises two principal members, the yoke and the crossrail. The latter can be swiveled in the horizontal plane for cutting tapers and angles. The openings in the yoke are 61 in. wide and 41 in. high, which accommodates six 6-in. frames or four 8-in. frames set on the bed for simultaneous slotting.

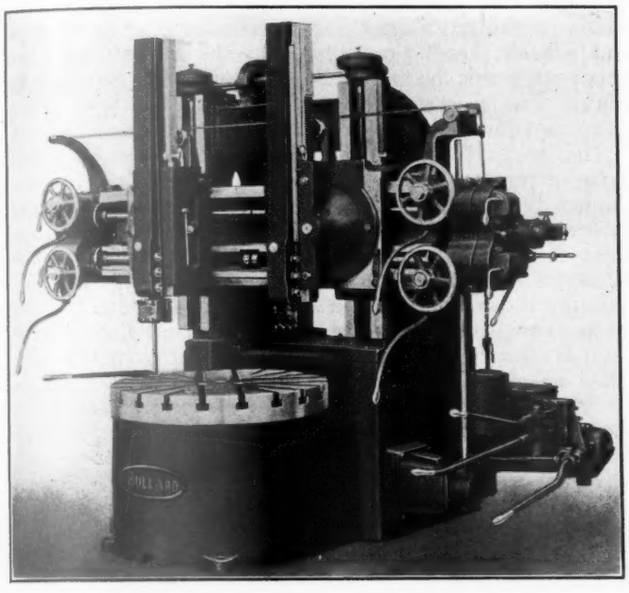
The extension tool bar is cylindrical in form, has a relief socket on the tool apron, and has its upper bearing in the cutter bar. The tool bar is revolved by a worm wheel gearing and hand wheels for setting tools or for cutting fillets.



Niles-Bement-Pond Locomotive Frame Slotter With Individual Reversing Motor Drive for Each Unit

Hand Feed Levers for Boring Mill

THE vertical boring and turning mill of today retains much of its original form, but facilities for quick change in a range of selective feeds and speeds, for more efficient and greater power application, and for convenience and accuracy in operation have made the machine of past decades into a modern production unit. Improvement in materials of construction, the use of heat-treated alloy steel in gears and shafts, continuous lubrication of all working parts, and the simplicity and convenience of control have aided in the development of a mill which far surpasses the older type of machine on any class of work.



Bullard Maxi-Mill Equipped with Hand Feed Levers

The Maxi-mill, a development of the Bullard Machine Tool Company, Bridgeport, Conn., embodies all of the above mentioned improvements in boring mill design and is now equipped with hand feed levers, a new feature which has proved extremely valuable in many classes of work. In many cases hand feed in heavy cutting is essential to high grade production both in quantity and quality, and definite aid to the operator not only conserves his energy but assures increased production and even greater accuracy. The many kinds of jobs done on the Maxi-mill in railroad shop and roundhouse work is one example of this. The tendency of the operator on any new work to start each cut by hand before throwing in the power feed is generally recognized. By using the hand feed levers the operator may stand in position to closely observe the cut while the greater leverage is of great advantage in holding the tool to the work against tough scale, or when machining chilled cast-iron or cast-steel. When the method of form templet and pointer attached to the tool slide is used, the levers permit the operator to watch this closely, guiding the cutting tool with greater ease and accuracy.

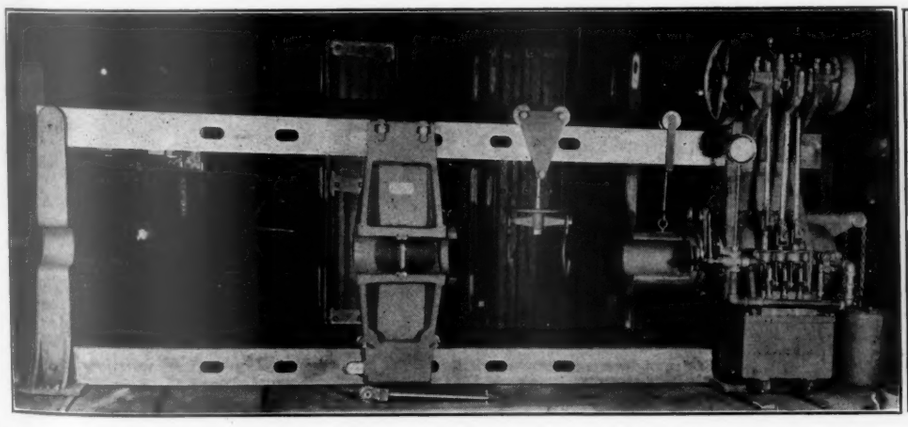
In construction each hand feed lever is pivoted on a free swinging collar mounted on the hammer hand wheel supporting bracket. Hardened steel clutch teeth, on the hub of the hand wheel and on the hand lever are engaged by a slight forward movement of the lever. When not actually held in engagement the lever automatically drops out of engagement, a feature assuring absolute safety in operation.

The advantages to be gained by using hand feed levers are apparent from the foregoing paragraphs and have been duly impressed by experience on anyone who has attempted to force a tool into a heavy cut by ordinary methods. The new feature is in line with modern developments for increased production, greater accuracy, and operating convenience.

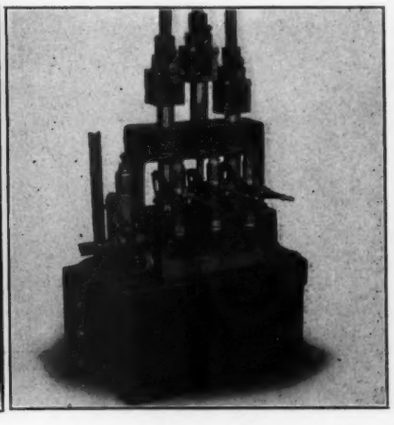
New Pump for Hydraulic Wheel Presses

THE pumping unit of a hydraulic wheel press is more subject to deterioration on account of wear than any other part of the machine and with this fact in mind the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, has developed a new pump featured by extreme rigidity, and careful guiding of all reciprocating parts, with provision for take up or replacement of all parts subject to wear.

An assembly of a three-plunger high and low pressure type of this pump which is known as the Class SS vertical single-acting type is shown in the illustration applied to a 400-ton hydraulic wheel press. The cylinder block is mounted on a casting which acts as a cover to the self-contained reservoir. This cover is provided with machined pads for the forged steel cylinder block and the cast crosshead guide.



400-Ton Hydraulic Wheel Press Equipped With Improved Three-Plunger Pump



Close-up View of Pump

The cylinder block is a one-piece steel forging with

plunger and valve cavities bored out, and renewable screwed-in bronze seats provided for the valves. Secured to the cylinder block and carefully alined with it is a one-piece cast crosshead guide provided with babbitted bearings of ample area. The crossheads are designed with a large diameter so that the bearing pressures resulting from side thrust from the connecting rods are extremely low. The crossheads are provided with wedge-type, brass-fitted, adjustable take ups. Grease cup lubrication is provided at this point. An adjustable spring-loaded safety valve of the latest type is used.

The Class SS pump is furnished in either two or three-plunger types, the former ordinarily being of the high pressure type while the latter is provided with one low and two high-pressure plungers. Both are provided with automatic knock-out or pump-unloading valves of the spring loaded type which are connected to the pressure chamber. The springs are set to balance a predetermined hydrostatic pressure and when this pressure is exceeded the springs compress and cause a system of levers to raise the suction checks from their seats thus rendering the particular cylinder which they serve inoperative. This is accomplished automatically and is particularly valuable in a wheel press since it permits the low pressure part of the stroke to be accomplished at high speed with all of the plungers of the pump operating. As the work in the press becomes more difficult and the pressure builds up, the knock-out valve on the low pressure cylinder functions as above described and holds the check off its seat rendering the cylinder inoperative during the balance of the high pressure stroke. The high pressure cylinders are also provided with knock-out valves which are adjustable and can be set to release at a predetermined high pressure point thus making it impossible to put an undue strain on the mechanism. This eliminates wear on the safety valve seats since that device is required to perform its duty only as an emergency safety appliance.

In addition to operating automatically the knock-out valves just described are provided with hand levers and may be thrown out thereby at the will of the operator. This permits a very minute control of the pressure stroke without changing the comparatively slow-moving operating valve and is particularly valuable at the completion of an accurate and difficult pressing operation. By the use of these hand knock-out levers, the movement of the press ram may be controlled down to one stroke of the pump. The hand levers in no way affect automatic operation of the knock-out valves.

The pump illustrated is arranged for direct-connected motor drive but it may also be provided with belt drive through tight and loose pulleys. The considerable distance between the eccentric shaft and the crosshead is an advantage since it reduces angular thrust on the crossheads. The eccentrics, driving the pump, are of exceptional size, thereby reducing the bearing pressures. They are provided for take up and equipped with grease cup lubrication. The eccentric shaft is a heavy steel shaft with the eccentrics keyed on. The Class SS pump is provided in four sizes from 7½ hp. to 15 hp. with considerable possible variation of capacity in each size made possible by a selection of plunger sizes. The entire stationary portion of the pump is rigidly tied together which maintains accurate alinement. All moving parts are amply guided. Wearing surfaces are provided either with antifriction metal or approved lubricating devices.

American Saw Table and Hand Jointer

THE universal saw table, illustrated in Fig. 1 and made by the American Saw Mill Machinery Company, Hackettstown, N. J., has been equipped with motor drive. The main table tilts to an angle of 45 degrees, and it is also a rolling table for cut-off work. Two arbors are provided, either one of which can be quickly placed in cutting position. These arbors are carried in ball bearings. Convenient hand

Fig. 1—American Motor-Driven Universal Saw Table

wheels provide for tilting the table and for adjusting the saws; a suitable guard is also provided for the saw, and all necessary ripping and cut-off and mitering gages. The table is 44 in. by 38 in. and saws up to 14 in. in diameter

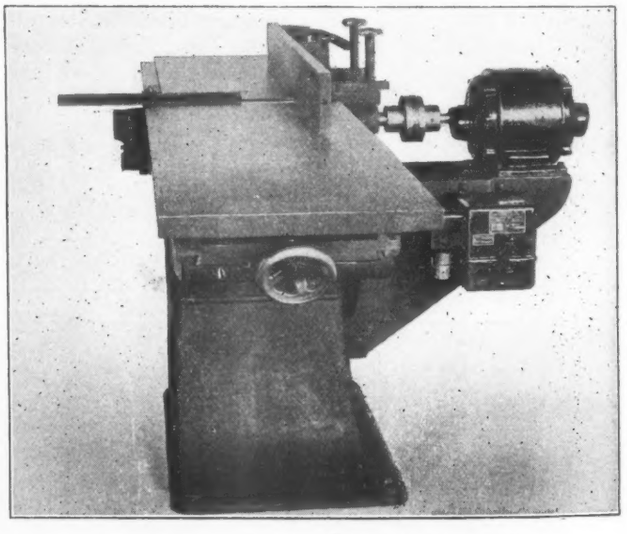


Fig. 2—Direct Motor-Driven Hand Jointer

may be used. The shipping weight with the motor is about 1,600 lb.

This company also has developed a universal saw bench with tilting table, the table being 36 in. by 48 in., with hand wheel adjustment for raising and lowering and also hand wheel adjustment for tilting the table. The motor is direct connected to the countershaft, and from this same countershaft may be driven the mortising attachment, furnished with the machine on special order. Saws up to 20 in. may be used.

Fig. 2 illustrates an application of direct motor drive to the American hand jointer, the motor being mounted on a sub-

stantial frame attached to the side of the main jointer base. The motor is connected by means of a flexible coupling. This motor drive is applied to 12, 16 and 20-in. jointers. The jointers are provided with a new type of round safety four-knife heads.

The American bench jointer has also been improved, being more substantial than earlier models and equipped with a 1-hp. direct-connected motor, mounted on a substantial base which is part of the main jointer base, and connected to the cutter head by means of a flexible coupling. This machine carries four 8-in. knives fitted to a round safety head. The jointer table is 48 in. long overall and the machine is equipped with all of the adjustments of a standard hand jointer.

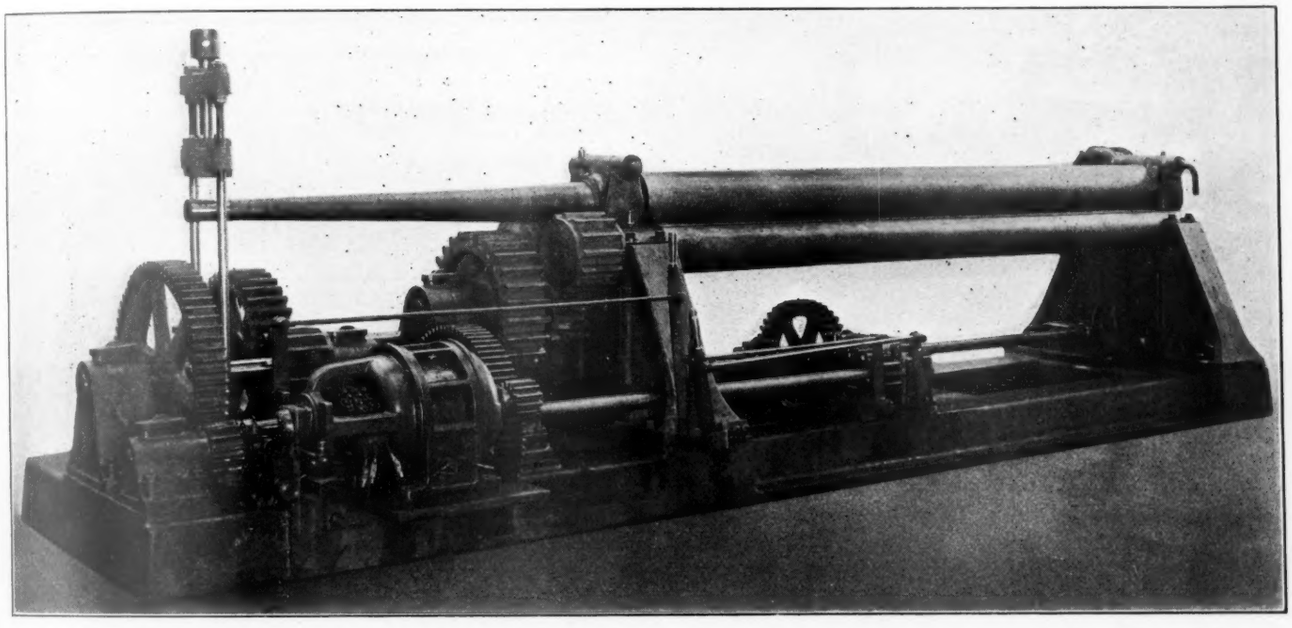
Direct-Connected Motor-Driven Bending Rolls

THE illustration shows a No. 2 Cleveland pyramid type bending roll, spaced 10 ft. 2 in. between housings, recently designed and built by the Cleveland Punch & Shear Works Company, Cleveland, Ohio.

This machine is direct connected, motor driven, entirely self-contained and is arranged for power raising and lowering of the top roll. One of the lower rolls (8 in. in diameter) has three splines; the other lower roll has two splines and a flanging groove. The upper roll is 11 in. in diameter. It will be noted that none of the gears protrude into the foundation, hence no expensive pit is required. Two clutches are provided so that either end of the top roll may be raised and lowered. An additional single clutch is used for starting the rolls.

This bending roll, as shown in the illustration, is featured by rigid construction and parts so proportioned as to stand the stresses imposed on them with an ample factor of safety. The roll boxes, yoke and elevating screws are all scientifically designed and made with a view to strength and durability.

When it is desired to drop the hinge at the right end, the cover plate can readily be lifted from the shoulder belts and the yoke dropped by one man.



Power Bending Rolls Recently Made By the Cleveland Punch & Shear Works Company—A Compact Motor-Driven Unit

Two New Developments in American Lathes

ONE of the two most important, recent lathe developments of the American Tool Works Company, Cincinnati, Ohio, is the new automatically-oiled, 12-speed, geared head illustrated in Figs. 1 and 2. On all sizes of American lathes up to and including the 36-in. medium pattern lathe this mechanism provides 12 mechanical spindle speeds in geometrical progression. All gears in the head are heat-treated manganese steel, of high tensile strength, and all speed change gears are hardened. The entire head is designed for maximum durability, low maintenance expense, and ability to perform the most severe service without appreciable deterioration.

Only three shafts are used in the new head. Therefore, the gear centers can be located farther apart, using larger diameter gears than in the average four-shaft head. The entire mechanism operates in a bath of oil, which in conjunction with the liberal proportions of the gears and shafts, and the carefully selected materials tends to insure long and satisfactory service with minimum wear.

As an example of the great power and rugged construction of the American automatically-oiled geared head, the 24-in. heavy pattern lathe is said to work a 20-hp. motor at its full capacity, while on the belt-driven head, the power is delivered to a 16-in. driving pulley by a 6-in. double belt.

The head is under instant control through either of two levers, one located at the right side of the apron, and the other at the left side of the head. These levers operate the powerful friction clutch incorporated in the driving pulley or the driven gear of the motor train, if motor driven. A powerful band brake operates in unison with the friction clutch,

and is engaged when the friction is released, and vice versa. In order to remove the belt pull from the driving shaft the pulley is bronze bushed and mounted on a long steel sleeve of large diameter, which takes the belt pull. Another decided improvement is the gear tooth clutch used on the high speed drive, providing ease of engagement and durability.

The automatic oiling system employed is a new development by means of which a geared pump, accessibly located inside the head, pumps oil from a reservoir in the bottom of the head to a filtering and distributing tank in the head cover, from which every bearing in the head is lubricated. Oil cascades over the gear teeth, keeping them constantly lubricated. Every drop of oil used for bearing lubrication is thoroughly cleansed and strained, thus insuring perfectly clean lubrication.

The oil first flows into a settling tank (Fig. 2) in the lower head casting, where all heavy particles of foreign matter settle to the bottom. As the oil accumulates in this settling tank it

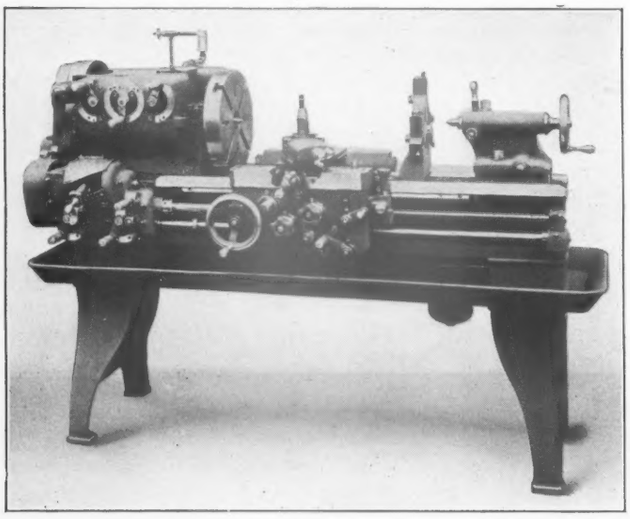


Fig. 1—American Lathe With Automatically Oiled Geared Head

overflows into a straining compartment, where it passes through a fine mesh metal gauze strainer into the pumping reservoir. From this point it is lifted by the pump into the filtering tank in the head cover, where it is filtered through a felt pad ½-in. thick before it reaches the distributing chamber, from which it is led to the various bearings located in the head.

A removable plug in the bottom of the settling tank provides means for removing the sediment from the tank, while a signal glass in the supply line from the straining compartment to the filtering tank shows the operator how the oil pump is working.

The new portable lathe illustrated in Fig. 3 is a recent addition to the American line. It has been developed primarily for railroad shop service and the factors of particular importance for such service have been given particular attention. The lathe is built in four sizes, 12-in., 14-in., 16-in., and 18-in. It is an exceptionally powerful and rigid machine, with the weight so distributed that it can be easily moved about the shop.

The motor is located in the leg under the headstock, thus bringing the center of gravity close to the floor, and minimizing the tendency to overturn when moved on an uneven floor. Power is transmitted to the twelve-speed, automatically-oiled,

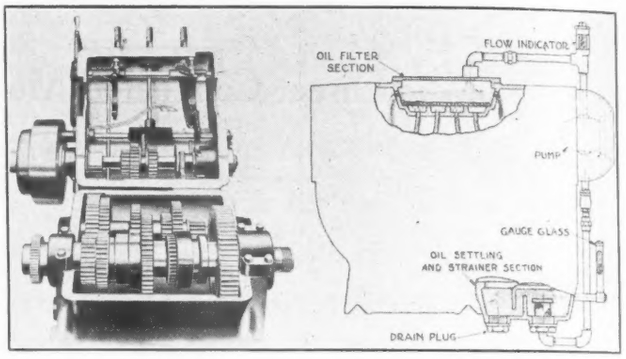


Fig. 2—Large Diameter Gears—Geared Head Oiling Diagram

geared head through either a belt or chain, and the machine is under constant control through a mechanical apron control lever at the right side of the apron. This lever engages and disengages the starting friction, and also operates the brake.

The lathe is mounted on three substantial cast-iron wheels running on ball bearings, and is supplied with a long handle

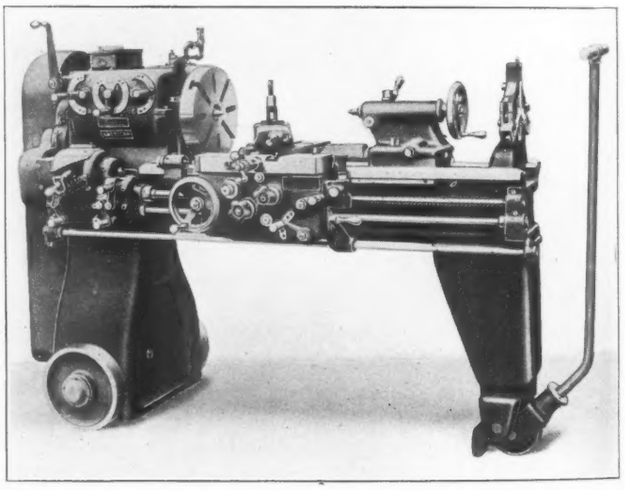


Fig. 3—Portable Lathe for Use in Railroad Repair Shops

so counterweighted that when released it brings a shoe into contact with the floor, which prevents movement of the lathe while in the operative position.

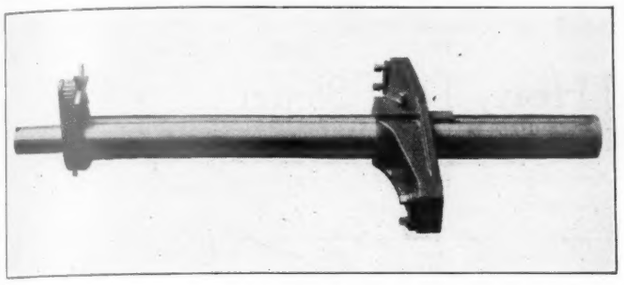
For driving this machine either a direct or alternating current, constant speed motor may be used, or, if preferred, a four-speed, simplified geared head can be furnished in place of the twelve-speed head, which is designed for use with a 3 to 1 direct current, variable speed motor.

Stationary Boring Bar for Cylinder Bushings

AN unusual boring problem has been solved by the Pedrick Tool & Machine Company, Philadelphia, Pa., in the stationary boring bar illustrated, having a cutter head which does not revolve but feeds along the bar. It was desired to bore large locomotive cylinder bushings on a relatively small vertical boring mill and this boring bar, shown in a horizontal position in the illustration but used vertically, enables the operation to be performed. The inside diameters of the bushings to be bored are 28 and 30 in. and the length 44 in. This made the distance under the

tool post of the boring machine limited, greatly increasing the difficulty of designing a suitable boring bar.

Referring to the illustration, the greater part of the bar is like the standard Pedrick 4½-in. cylinder boring bar but



Pedrick Boring Bar Used for Boring Locomotive Cylinder Bushings

with a shank turned down to fit into the toolpost. The end of the shank is cross slotted to receive the holder. The right end of the bar is bored for a pilot, held in the table of the boring mill. Hence the bar is supported both on the top and bottom, an essential feature in view of the dimensions of the bushings.

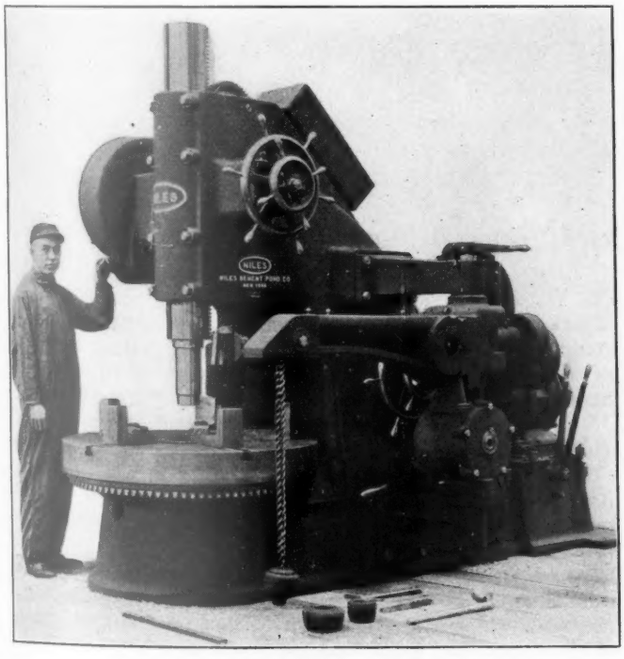
The provision of a feed mechanism was also something of a problem. It was found that merely affixing a star wheel to the end of the feed screw would necessitate such a deep slot or gash in the bar (owing to the let-in screw) that the latter would be less strong than necessary for the job. Furthermore, the bearing of the screw plus the star wheel would make the bar an inch or so too long.

The illustration shows the feed gearing arranged with axis parallel to the bar, and with the star wheel on the end where it can function without weakening the bar. The bushing being bored carries a knocker, which engages the star at each revolution and causes the cutter head to feed downward. On a test run it is said that this bar worked satisfactorily and that considerable economy resulted by boring the bushings in this manner on the same machine upon which they were otherwise machined. The boring mill was kept working to capacity and there was no rehandling and resetting of the work.

Forty-eight Inch Car Wheel Borer

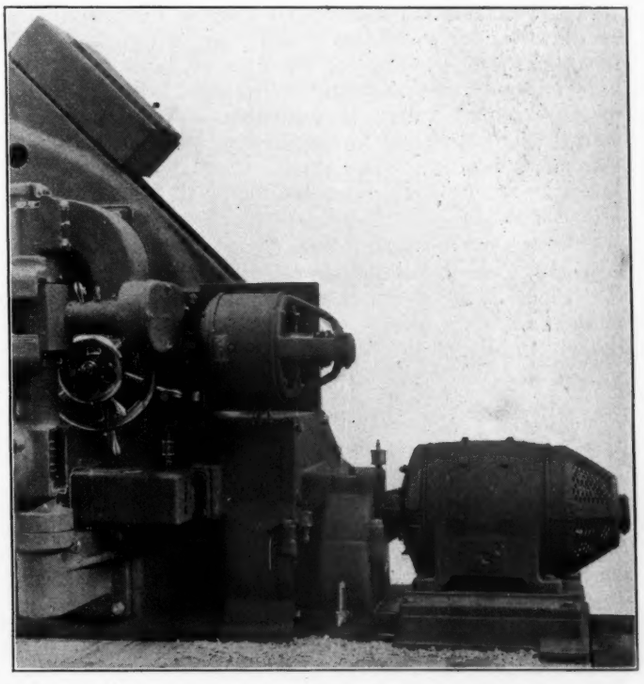
THE new 48-in. car wheel borer brought out by the Niles-Bement-Pond Company, New York, comprises several features which tend toward increased production and safety. The frame itself, all one casting, has been made heavier, which promotes output because of greater rigidity gained with the accompanying ability to take heavier cuts. The pattern of the frame has been altered in such a way as to give greater support to the hub-facing bar which also makes heavier cuts possible.

The automatic self-centering chuck is an interesting and time-saving feature of the new model. After the wheel to



An Automatic Self-Centering Chuck Is a Feature of the New Niles 48-in. Car Wheel Borer

be bored has been swung into place on the table by the motor-driven crane supplied on each machine for that purpose, the motor is started at a slow speed in the regular way. A mechanism in the table causes the chuck jaws to move inward until they engage the wheel tread. When the job is firmly chucked, the table commences to rotate and the driving force employed after the cutting operation begins



View Showing Rugged Main Drive and Crane Motors

only serves to further lock the wheel in the jaws. When the job is finished, the motor is reversed and relative motion between the driving gear and table serves to loosen the jaws and withdraw them toward the periphery of the table after which the motor is stopped and the wheel removed by the crane.

The boring bar counterweight operates down an incline on the back of the machine frame, and is so arranged that in the event of the support chain breaking, the counterweight is prevented from falling.

Where a shop is equipped with direct current, dynamic braking can be applied. For either direct or alternating cur-

rent, the machine uses reversing motors, the different table speeds being obtained by using a variable speed motor in the case of direct current and a constant speed slip-ring motor operating through a speed change box where alternating current is used. No clutches are used in either case.

Although the machine can be furnished belt-driven for shops which are not able to provide individual motor drive, electric drive is recommended for economy of power consumption, dynamic braking, and reversing motor features as well as the use of a motor for operating the small crane.

Conveniently-Operated Heavy-Duty Slotter

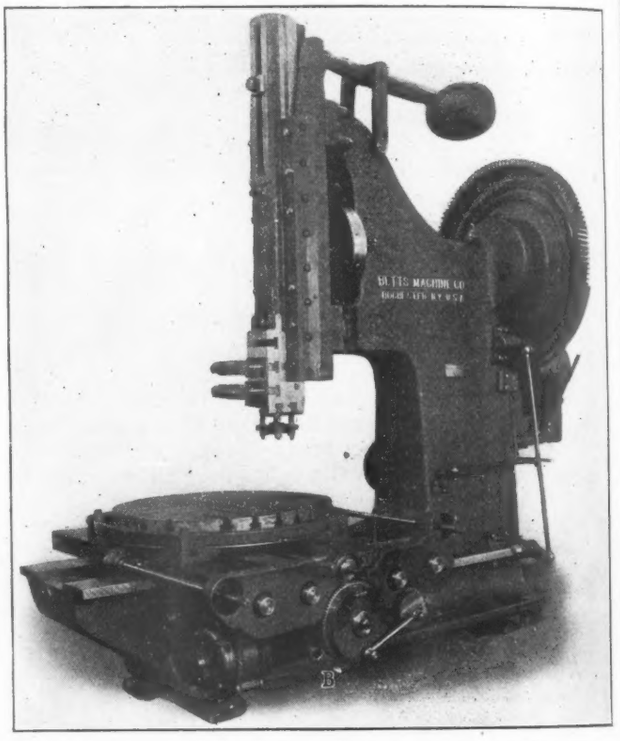
AN 18-in. heavy-duty slotter of special interest on account of the features incorporated for convenience of operation has been built recently by the Betts Machine Works of the Consolidated Machine Tool Corporation, New York.

The ram is driven by a 7½-hp., alternating current motor, constant speed squirrel cage type, with a suitable range of ram strokes provided through sliding gears in a box on the back of the machine.

Quick stopping of the ram is accomplished by means of a friction clutch and brake mounted between the motor and speed gears. The clutch and brake are engaged and disengaged by means of a lever controlled from the operating position, making it unnecessary to stop the motor when stopping the ram. This saves drifting time common to alternating current motors. In other words, the ram can be stopped instantly in any position.

The tables are equipped with quick power rapid traverse driven by a separate 3-hp. motor. Lever *B* disengages the feed and engages the power rapid traverse, selective to either saddle or tables by sliding a slip gear into position. The motor has rotor windings of the high resistance type to provide for quick stopping, and is equipped with a reversing magnetic control panel. A push button station, providing for start, stop, reverse and jogging movements, is mounted in a convenient position. The small motor is mounted on the underside of the saddle out of the way. All the control levers are arranged for easy manipulation.

Other features include a relief tool apron made of steel, adjustable ram and ram guide for adjusting the stroke to suit the height of the work; large diameter feed cam requiring minimum of ram stroke for feeding action, one piece rigid frame designed to eliminate spring under heavy cuts, convenient arrangement of speed changes through sliding gears controlled from operating position, and adjustment of feed convenient for operation.



Betts 18-in. Heavy-Duty Slotter Easy to Operate

A New Material for Making Gears

A MATERIAL for making gears which possesses the qualities of quietness in operation, strength and practical imperviousness to oil, which is not affected by atmospheric changes, which is elastic and long lived, which

Textoil Gear Board Designed to Make Strong, Quiet Gears

makes the use of metal shrouds unnecessary and which is vermin proof, has recently been devised and placed on the market by the General Electric Company, Schenectady, N. Y. It is known as Textoil gear board and consists of layers of an especially strong, closely woven canvas, highly compressed and permanently held in compression by means of a compound with which the whole mass is fully impregnated and finally set by a curing process. These boards are 35 in. square, the thickness ranging from ¼ in. to 3 in. (both inclusive).

The refinements made for increasing machine efficiency have increased speeds to the extent of producing excessively noisy gear trains. Gears of Textoil board are said to have proved highly effective in quieting them. Shocks and vibrations of surrounding parts are also largely eliminated where this material is employed, because of its elasticity. The elasticity which characterizes it is due to special treatment of the fabric that leaves the finished board with live cotton fibers.

Textoil is nearly as strong as cast iron and runs equally well meshed with cast iron, steel or bronze. Its oil and water absorption being practically zero, it may be run in hot oil or under conditions in which it is splashed with oil, with complete success, while it is also proof against atmospheric changes. It neither shrinks nor swells in extreme dryness

or dampness, and may be stored indefinitely without damage.

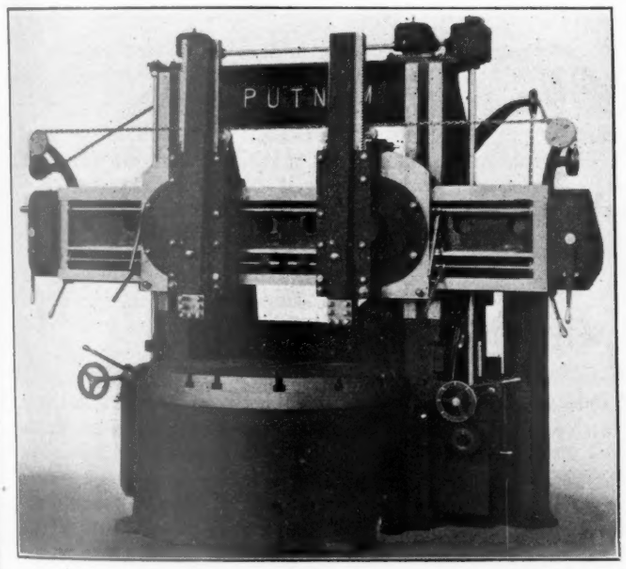
The use of Textoil gears is advisable in gear trains running 700 ft. or more per minute at the pitch line. For general applications the maximum speed should be kept within 2,000 ft. per minute as usually figured for metal gearing. Under suitable conditions of design of surrounding parts, the speed may be much higher.

Common types of machinery on which Textoil gears are used include fractional horsepower motor drives and machine tools. For the manufacture of small gears, and as a general utility gear material, Textoil gear board is especially adapted. As it can be stored indefinitely, it provides an immediate supply of gear material from which finished gears can be quickly made. Miter gears or bevel gears with the pitch angle even greater than 45 degrees can be made satisfactorily from it.

Putnam Heavy-Duty Boring Mills

THE Putnam Machine Works of Manning, Maxwell & Moore, Inc., New York, has recently developed an improved model heavy-duty vertical boring and turning mill in several sizes ranging from 44 in. to 74 in. swing. The drive, speed changes, hand manipulations, feed and rapid power movements of heads, operation of clutch and brake are all centralized and controlled from both sides of the machine with equal convenience. All gearing is of steel and all bearings are bushed with bronze.

The table is exceptionally heavy and provided with finished parallel T-slots and additional radial slots. The table spindle is of large diameter, accurately ground and runs in two long bushed bearings in the bed. The table



Putnam Mill Featured by Massive Proportions and Duplicate Control

also carries a conical seat which absorbs vertical and side thrusts and automatically preserves the spindle alinement. The spindle and the conical seat run in a flood of oil. An adjustable nut at the lower end of spindle resists any lifting tendency. The table drive is by bevel gearing which also runs in oil.

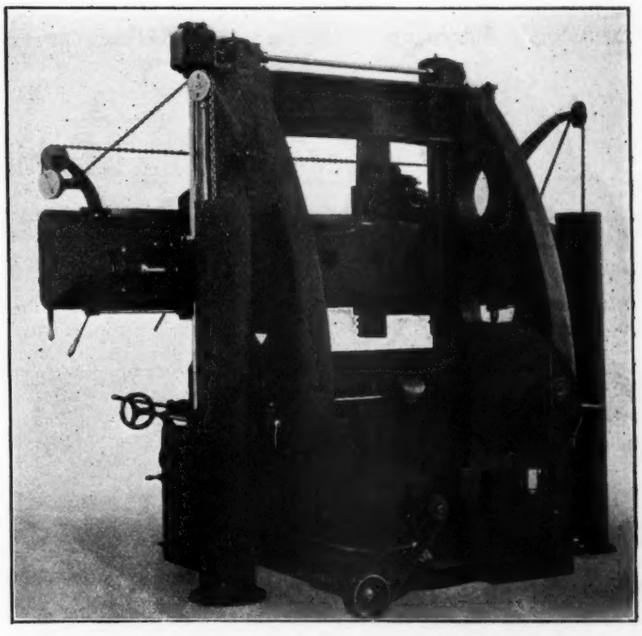
The crossrail is of the three-track type with the traversing screws always in tension and located between narrow guiding surfaces at the bottom. The crossrail is raised and lowered by power with stops to automatically limit the up and down travel. The saddles are fitted with taper gibs for taking up wear. The bars are of rectangular shape fitted with gibs for adjustment, and each bar is arranged to swivel 45° on either side by means of a worm, controlled by a ratchet.

Binder bolts lock the saddles or bars when desired. Ratchets are located on the heads for hand operations and, final tool adjustments, large micrometer dials facilitate accurate and duplication tool setting. Twelve positive feeds ranging from .005 in. to ¾ in. cover all requirements. A safety clutch prevents accident, in case heads or bars meet an obstruction while feeding or fast traversing.

Belt drive is by constant speed single pulley and multiple dry disc clutch. Constant speed motor drive is by motor of about 1,100 or 1,200 r.p.m. mounted above the gear box and directly geared to it. A gear box, embodying a powerful multiple dry disc clutch and brake, gives twelve selective all-geared speeds which are operated by only two levers. The friction clutch and control levers are in duplicate, permitting full control of speeds with equal facility from either side of the machine.

All gears are alloy steel, heat treated and hardened, running in a bath of oil. The shafts are of large diameter, running in ball bearings of extra large size, thereby reducing friction and its attendant wear and upkeep expense, and permitting a greater proportion of the power used to be delivered at the cutting tool and converted into useful work.

When driven by an adjustable speed motor of 3 to 1 ratio



Rear View Showing Adjustable Speed D. C. Motor Drive

the motor is directly geared to a three-speed gear box. The speed changes are operated by only one lever, which is in duplicate, permitting full control of speeds from either side of the machine.

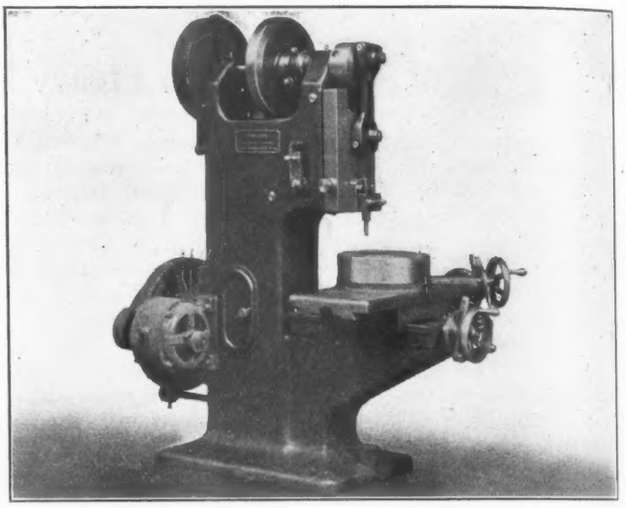
A separate motor as shown in the accompanying illustration drives the power rapid traverse and elevates the crossrail. This motor is only used when the machine is driven by an adjustable speed motor. It will be noted that the motors are located on the base rather than high on the housings.

Bossert Vertical Die Slotting Machine

ARRANGEMENTS have recently been made by the John Steptoe Company, Cincinnati, Ohio, to build the improved Bossert die slotting machine. This is a vertical slotting machine designed especially for use in making round, square and irregular shaped punches and dies. Its purpose is to eliminate as much as possible, the hand work in connection with die making. Two sizes are now being manufactured, one having a length of stroke up to four inches and the other up to six inches. The machine is of simple construction and there are no complicated parts to get out of order. The ram is driven by a crank, connected at the upper end of the crank pin to the crank disk on the main shaft. The crank pin is adjustable so that the length of stroke can be adjusted from 0 to 4 in. on the smaller machine and from 0 to 6 in. on the larger machine. The ways are hinged on the upper end in such a way that they can be set at a slight angle to obtain the required amount of clearance in die opening. The ways are fitted with taper gibs. The crank arm at the lower end is attached to a pin located in a slot in the ram, the position of this pin being adjustable in order that the location of the ram path may be altered to suit the work in hand.

The lower end of the way may be connected by the manipulation of a pull-pin to a toggle-joint mechanism operated by an eccentric on the main shaft. When connected, this mechanism moves the ram over a curved path on the down stroke, thus enabling it to take curved cuts in dies. The mechanism also causes the tool to clear the cut on the up stroke, the amount of clearance being adjustable to suit the requirements. When the toggle-joint mechanism is disconnected, the mechanism is set for taking straight cuts.

This improved die slotter can be furnished with cross, longitudinal, and circular hand feeds and also with power feeds if wanted. A variable-speed gear box, mounted inside the column furnishes three changes of speed, these being secured by means of a shifting lever, conveniently located on the outside of the column. The machine is arranged with a circular table graduated in degrees, provided with an index pointer.

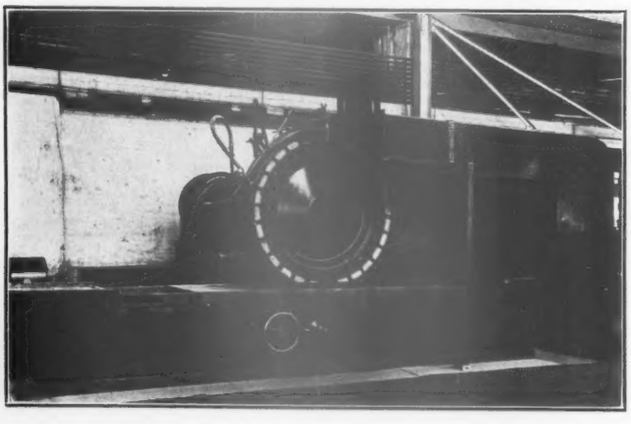


Bossert Die Slotting Machine of Improved Design

The illustration shows the machine arranged for motor drive; it can also be arranged for belt drive, which is furnished with tight and loose pulleys.

Face-Grinding Machine with 66-Inch Wheel

THE Diamond Machine Company, Providence, R. I., has recently built for the United States Radiator Corporation, Detroit, Mich., a face-grinding machine designed to grind boiler sections having a height of 60 in. To grind work of this height, the machine is equipped with an abrasive wheel having an outside diameter of 66 in. This is said to be the largest wheel ever put on a face-grinding machine.



Diamond Grinder with Wheel of Unusual Power and Size

In conformity with the standard design for Diamond face-grinding machines, the abrasive wheel is of the sectional type. There are 28 separate blocks of 2-in. face and 7¼-in. depth, each held with absolute rigidity in a special chuck. The design of the chuck will allow the use of 90 per cent of the abrasive material in the blocks before it is necessary to replace them with a new set. A wheel dresser built on the machine may be used while the machine is operating and without stopping production.

A tremendous cutting power is available at the face of this wheel due not alone to the driving force of a 75-hp. motor, but also to the kinetic energy stored in the rotating wheel, chuck and spindle. The drive from motor to wheel is through a Morse sprocket and silent chain and gives a speed of 180 r.p.m. to the wheel. The wheel spindle has a maximum diameter of 9 in. and is provided with ample bearings for rotation and end thrust.

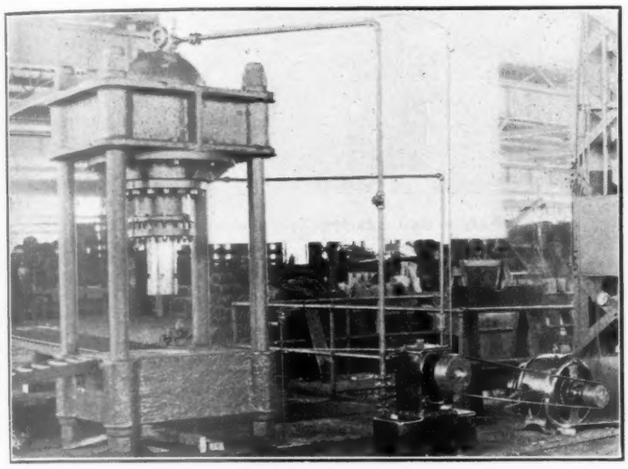
Two large nozzles deliver an easily adjusted supply of cutting solution or water to the wheel. Substantial sheet metal guards prevent splashing and protect the bearings of the machine. A complete automatic system is provided for pumping the solution from a 140-gal. tank at the rear of the machine, collecting it after it has passed the wheel and settling out the solid material before the solution is circulated again.

The traveling table for passing the work across the rotating wheel has a platen 36 in. wide and 110 in. long with numerous slots for attaching the fixtures and work. The table speed is 22 ft. per min. Control of the motion of the

table is provided at the front of the machine and also at the operator's position behind the table. Reversal of the motion of this heavy table is accomplished with slight shock by means of a patented arrangement of belts and pulleys within the bed of the machine. The total weight of the complete machine is about 40,000 lb.

Variable-Speed Drive for 150-Ton Press

THE advantages of hydraulic variable-speed drive in perfect control of speed, absence of coasting, elimination of peak loads and low maintenance have been demonstrated in the 150-ton press installation illustrated.



Type W Oilgear Variable-Delivery Pump Driving 500-Ton Press

This press has been equipped recently with hydraulic variable-speed drive by the Oilgear Company, Milwaukee, Wisconsin, being used for assemblying spring buffers for draft gears. With the new variable delivery pump the press averages 35 spring buffers an hour. The draft gear contains heavy coiled springs which must be compressed at a certain point so that iron bands can be put on the assembly. This operation requires perfect ram control in both directions as well as the ability to stop at a fixed point under load, while the bands are applied, the load being then gradually released.

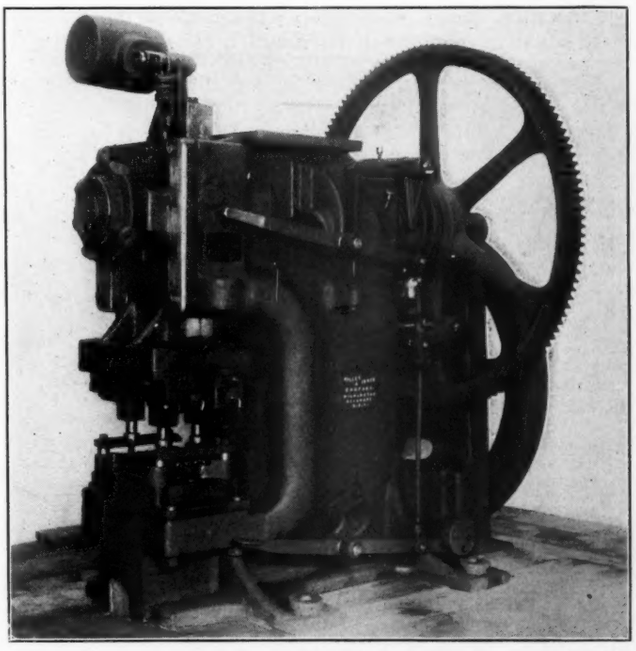
The type W Oilgear variable delivery pump which operates this press (shown in the right foreground of the illustration) is well adapted to these conditions. The control handle at the corner of the press is so connected to the pump that the pump stroke can be varied from zero to a maximum in any direction. Changing the length of the pump stroke regulates the amount of oil that is pumped into the press cylinder and thus controls the movement of the ram with great accuracy.

This pump is featured by light weight and takes up considerably less room than a water pump. It is driven by a constant speed electric motor. The diameter of the press cylinder in this case is 19 in., the ram diameter being 10 in.

Tie Plate Punch on Reclamation Work

MODERN features of construction have been included in the tie plate punch illustrated which has been developed recently at the Hilles & Jones Works of the Consolidated Machine Tool Corporation, New York. This machine is now used in a prominent railroad shop for repunching tie plates in reclamation work. After service the tie plate holes become worn and in order to utilize these old plates, two new holes are punched at one time, diagonally opposite each other, the tie plates then being replaced in service. In addition to the four punch attachment to the machine a cross cutting attachment with knives for shearing flat, round, or square bars is also provided. Two machines of this type are now being used on reclamation work.

Referring to the illustration, the rugged construction and powerful drive of the machine will be evident. The throat depth from the center of the sliding head is 12 in. The machine has a capacity to punch six square inches and is ample for punching at one stroke, two ¾ in. square holes through material ¾ in. thick. Round bars 2¼ in. in diameter or flat bars 1½ in. by 7 in. made of mild steel can also be sheared. The machine is shown in the illustration fitted with four ¾ in. square punches, each controlled by a separate hand gag. The punches are adjustable both ways 3½ in. to 6 in. parallel with the main shaft and 3 in. to 8 in. at right angles to the main shaft. The vertical opening of the jaw is 26½ in. The two filling blocks bolted to the bottom of the sliding head, punch holders, die block holders and die blocks are all made of steel. The die blocks carry dovetail dies, grooved to accommodate the rib on the tie plate. The ties are adjustable to correspond with the adjustment of the punches. There are two plate strippers, and an adjustable guide at the back of the die holder for locating the holes. The stroke of the machine is 1¾ in., the speed being 25 strokes a minute. All gearing has machine cut teeth. The clutch is controlled by an automatic stop. All shaft bearings are bronze bushed. A ratchet spider



Hilles & Jones Tie Plate Punching Machine

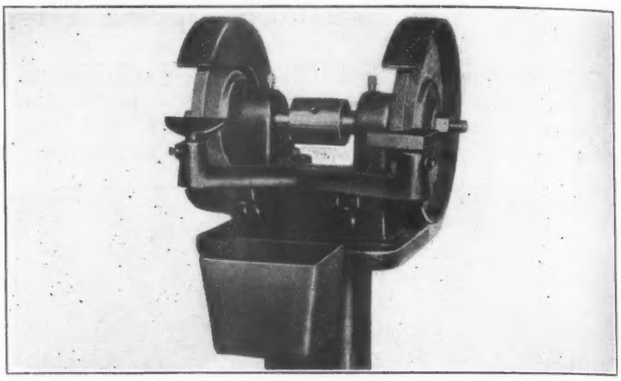
fitted on the front end of the main shaft provides for bringing the head down by hand. Ten horsepower is required to drive this machine.

Tool Grinder Driven from Main Shaft

AS a rule tool grinders in railroad as well as other shops are for everybody's use, and too often nobody cares enough to give them the little attention needed to keep them in good condition. When a tool has been ground the shifter is given a careless slap and the operator walks away often leaving the grinder still running. The result is that with plain bearings in the grinder and also on the countershaft, wear frequently develops to such an extent that the grinders become noisy, out of true and cannot be used to grind tools accurately.

With these facts in mind the Fafnir Bearing Company, New Britain, Conn., has developed a ball-bearing tool grinder, designed to run continuously from any line of shafting, doing away with all countershafts and loose pulleys. Fafnir alloy steel ball bearings are used, providing long life and practically frictionless revolution of the grinding wheel spindle. These grinders can run all the time that the plant is running without harm to the bearings, being ready for instant use at all times. The only attention required is a few drops of oil about once in two weeks, and the only time the grinders need to be stopped is in changing wheels.

Railroad shops as a rule are equipped with an insufficient number of tool grinders of the type illustrated and many of those available are not maintained in good condition as regards bearings and cutting surfaces of the abrasive wheels in view of the importance of sharp cutting tools.

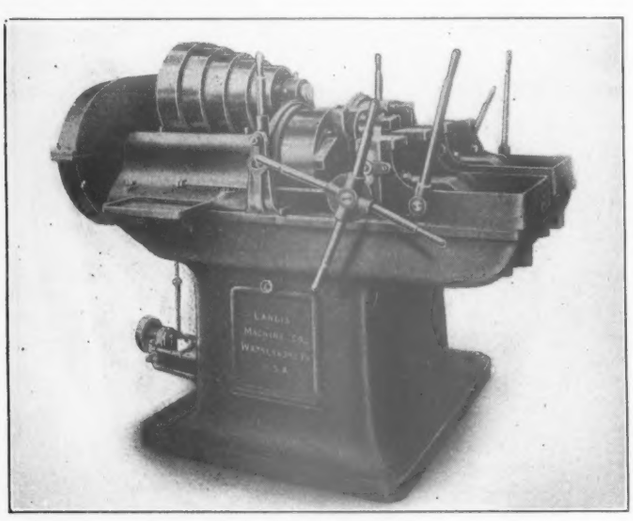


Fafnir Ball Bearing Tool Grinder No. 3

Pipe Machines with Internally Tripped Die Heads

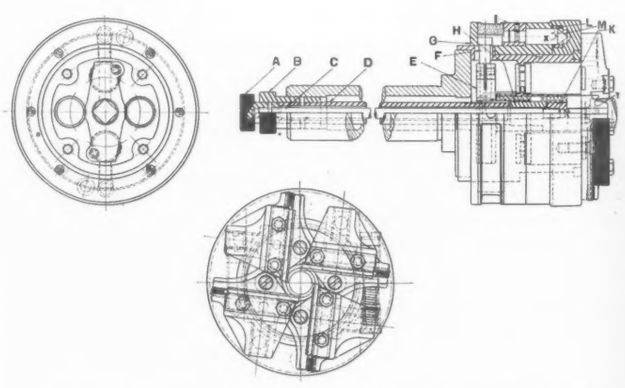
THE Landis Machine Company, Waynesboro, Pa., is now making an improved type of pipe and nipple-threading machine with internally tripped die head. This type of head automatically insures a uniform length of thread on nipples and eliminates the necessity of gaging each nipple by hand. The new machine will thread, ream and chamfer both pipe and nipples.

The drawing illustrates the principles of operation of the Landis internally tripped die head. The knurled collar *A* and the clamping rod *C* are integral. The clamping rod *C* is threaded on one end which screws into a tapped hole in the shank of the reamer *K*. Knurled collar *B* is integral with the tube *D* which is threaded on one end and screws into the spider *E*. Spider *E* has a square hole through it and furthermore is tapped part of the way to fit tube *D*. This gives thread bearings on the four sides of the square hole. The reaming portion of the hole in the spider is plain, to afford a bearing for the driver *H*. Driver *H* has a square hole in the end to receive the shank of the reamer *K*.



Landis Pipe and Nipple Threading Machine

To set the reamer to the correct position, the knurled collar *K* is drawn tightly by hand. This clamps together in one unit, tube *D*, driver *H* and reamer *K*. The surface *Y* on reamer *K* has no cutting edge. Therefore, as the nipple is being threaded and the end begins to bear on reamer *K*, the units *D* and *H* transmit the pressure to spider *E*.



Drawing Showing Construction of the Internally Tripped Die Heads

Through the medium of pins *F* in spider *E*, rings *G* and *I* are carried backward for a distance *X* or until pin *M* is disengaged from bushing *L*. The full opening movement is then completed by a spring in the adjusting ring.

To adjust reamer *K* longitudinally, the clamping rod *C* is unscrewed by turning knurled collar *A* to the left. Collar *B* is adjusted to right or left for either forward or backward movement depending upon the length of the thread to be cut.

This new Landis internally tripped die head and machine, employing Landis high speed steel chasers and chamfering reamers, is made in the ½ in., 1¼ in., 2 in. and 4 in. sizes and in both single and double spindle types.

Ball Bearing Hand Grinders and Drills

THE Cincinnati Electrical Tool Company, Cincinnati, Ohio, has recently added to its line of portable electric drills, grinders and buffers a new series of improved high-power drills, in ¼-in., 5/16-in. and ⅜-in. capacities, all of which are equipped with ball bearings and air cooled. They are high-speed, production tools for continuous duty, with universal motors, for use on either direct or alternating current. The housings and end caps are constructed of aluminum to give the lightest weight possible.

The armature shaft and also the gear studs are mounted on ball bearings to reduce the friction load to a minimum and increase the power. A patent make-and-break switch is conveniently located in the pistol grip handle, and has a 50 per cent overload allowance.

These drills are furnished complete, with a three-jaw geared chuck, rubber-covered cable, steel-clad non-breakable attachment plug and extra detachable side handle. They are sent out complete, ready for the work. It will be noted from the illustration, that they are particularly adapted for close corner work.

The Cincinnati Electrical Tool Company, has also developed a series of universal motor hand grinders and buffers, in ¼ and ½-hp. capacities. The housings, end caps, extension and wheel guard, are made of aluminum, as in the case of the drills to give the lightest weight possible. They are equipped with ball bearings throughout, so as to reduce friction and give the maximum power. These machines are particularly adapted for grinding, buffing and polishing of all kinds, and any kind of wheel, buff, or wire brush can be used.

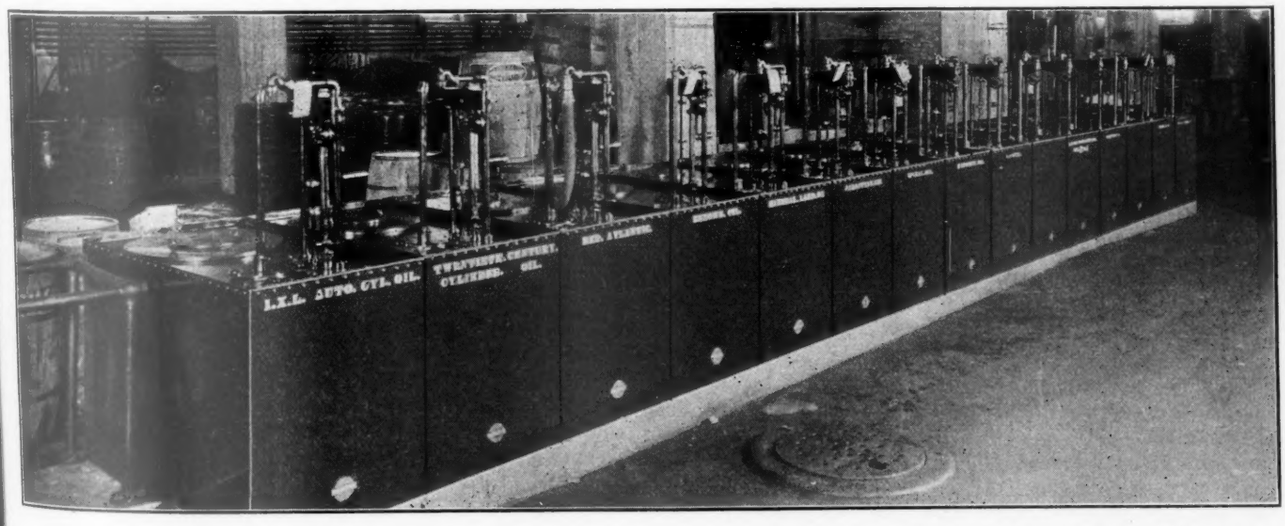
Portable Electrical Hand Drill—Air Cooled, Ball Bearing

Cincinnati Universal Motor Hand Grinder and Buffer

An Effective System for Storing Oils

THE oil storage system, shown in the illustration, has been developed recently by the Milwaukee Tank Works, Inc., Milwaukee, Wis., and proved effective in saving leakage, spillage and time of workmen who handle oil out of the different containers. In these items alone the installation illustrated is said to have paid for itself in a single month. The oils are kept in separate containers in battery formation, each tank being stenciled to indicate the kind of oil it contains and equipped with either a gallon or quart pump. This system also keeps oils clean and free from any grit. With the Milwaukee System, whereby the correct amount of oil can be measured out, waste is eliminated, and the different oils are kept in the purest and cleanest condition.

A manhole is provided on each tank so that at any time the tank can be thoroughly cleaned. Evaporation losses which are always large when oils are stored in barrels are prevented, this system being evaporation proof. All the battery systems are made in the same size as to length but vary in capacities. This system is also sometimes installed in railroad cars so that the different stations can be supplied with any class of oil which they are using in quantities



Milwaukee Oil Storage System Said to Have Paid for Itself in a Month by Preventing Leakage, Spillage, Deterioration, etc.

desired. In this manner one man can handle a carload of oil and distribute it among the different stations along the line without waste.

Experience has shown that on the average where oils are handled in barrels, two per cent is lost by lack of draining, five per cent by leakage from barrels in storage, one per cent by spillage, two per cent by deterioriation and contamination. Also four cents per gallon is lost by not buying in bulk, insurance is 25 cents a 1,000 gals. higher and 10 min. per gal. is lost on oil handled from barrels. These losses are largely eliminated by the oil storage system illustrated.

An Unusual Gang of Milling Cutters

INTERLOCKING milling cutters which are made entirely interchangeable as to position and can be used in sections or as a complete set-up, are somewhat out of the ordinary. Fig. 1 shows such a gang of cutters recently manufactured by the National Twist Drill & Tool Company, Detroit, Mich. It will be noted that the entire set-up consists of six cutters; two right-hand spiral and two left-hand spiral plain milling cutters, also one right-hand and one left-hand side milling cutter.

On a certain portion of the work to be milled, the groove

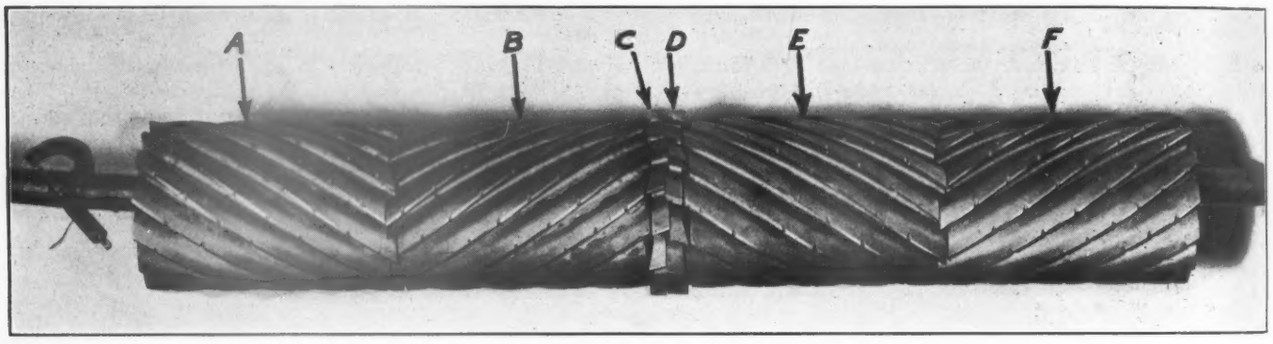


Fig. 1—Gang of Interchangeable Milling Cutters with Parabolic Shaped Teeth

produced by the two cutters *C* and *D* was not wanted. The gang was, therefore, so constructed that these two cutters could be removed and cutter *B* interlock with cutter *E*, producing a plain surface the full width of the entire gang. This width was about 32 in. with the center cutters removed. Later it was also found that only two of the cutters, *A* and *B*, or *E* and *F*, could be used to advantage on certain operations.

The arrangement of interlocking lugs is shown in Fig. 1, which also shows the chip breakers introduced on all the plain milling cutters. The angle of spiral used is about 35 deg., this being found from experience to insure maximum

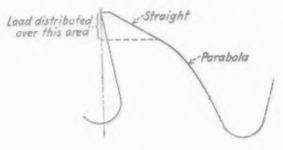


Fig. 2—Outline of Parabolic Milling Cutter Tooth

smoothness of operation. All of these cutters are made with the parabolic form of tooth now used as standard by the National Twist Drill & Tool Company.

The parabolic principle is to make the teeth in a milling cutter of such shape that they possess uniform strength throughout. The cutter tooth is considered a cantilever beam with the load applied over a small portion of the beam near its extreme end. The resulting shape is illustrated in Fig. 2. The section opposite where the load is distributed becomes wedge shaped, while the remainder of the tooth is in the form of a parabola.

In its practical application this shape has several advantages. First, it gives a tooth of uniform strength throughout. This in turn means that there is no excess metal at any point which might encroach on the very necessary chip space. Second, it assures maximum grinding life due to the straight portion immediately behind the cutting edge. Fig. 3 shows the parabolic shape of tooth superimposed over some of the designs in general use at the present time. Full lines indicate these designs, while the parabolic shape is shown in dotted lines. At *a* it can be seen that the straight back tooth is very weak in the middle, having no adequate section at this point to take care of the load at its outer end. The tooth *b* has the necessary strength, but here is found an excess of metal at *p* which is present at the expense of chip space and which will also hinder the easy egress of chips. The same can also be said of the tooth *c*, there being excess metal at *r*. In this

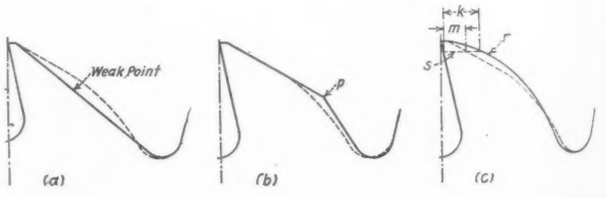


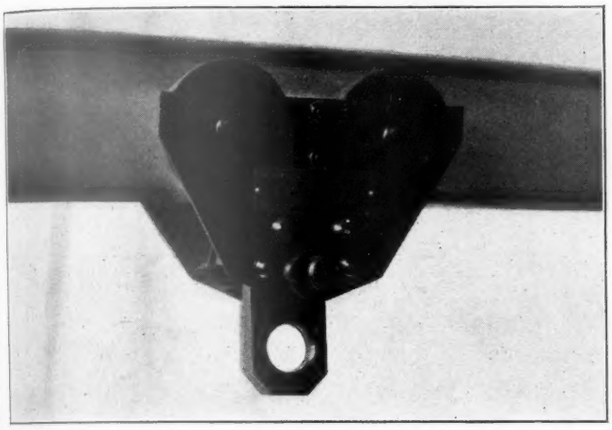
Fig. 3—Parabolic Shape Superinposed on Three Common Tooth Shapes

case the distribution of the excess metal also causes another disadvantage. After repeated sharpenings to a point *s* it will be seen that the width of land is equal to *k* for this shape, while the width of land on the parabolic tooth is only equal to *m* when sharpened back to the same point. When this land has reached a certain width the cutter must be snagged out in order to work efficiently. The advantage of the parabolic shape from this and other points of view is therefore obvious.

Strong and Flexible Steel Plate Trolley

AS a rule trolleys that possess unusual strength are rigid, and those that have the necessary flexibility are weak. The Yale & Towne Manufacturing Company, Stamford, Conn., has recently developed a trolley designed to be strong and flexible enough to meet every industrial requirement. In order to demonstrate the strength of Yale trolleys the following test was performed.

A Yale two-ton steel-plate trolley was tried successively



Yale Steel Plate Trolley Combines Strength and Flexibility

under various over-loads until finally it supported 14½ tons without breaking. At this load the 10-in. 1-Beam track on which this trolley ran, bent down so that the load was deposited on the ground. A careful examination of this trolley, after supporting a load 7¼ times its rated capacity, showed that the wheels, axles, bearings and other important parts of the trolley were the same as new.

Ease of operation or flexibility is a deciding factor in making many installations, and the new Yale Steel-Plate trolley, in the 1-ton size, can be run on a minimum 21-in. radius curve without binding, since the non-rigid construction permits each wheel flange to take a position at all times suited to the curve of the I-beam flange.

The wheels are mounted on roller bearings, attached to the side plates, and the side plates in turn are connected together by a single equalizing pin which supports the shackle plate. The spreader castings are riveted to each plate. These give a large bearing surface for the equalizing pin and are so shaped as to protect the trolley and act as a bumper which engages the track-stop on the lower flange at the end of the I-beam track. The strength of this construction is such that a full-load may be safely carried on either plate.

The roller bearings are heat treated, hardened and ground to assure easy lateral motion and the grease chamber design prevents dust from reaching the bearings. The axles are pressed into the wheel-hubs and supported by an inner bearing plate, are subjected to practically no bending strain. The wheels with chilled iron treads conform to the shape of the I-beam flange, greatly increasing wheel life due to the resistance which this surface offers to dust and grit.

A single equalizing pin of cold-rolled steel supports either the shackle eye or clevis, and where every inch of headroom is needed the chain block can be hooked directly over the equalizing pin.

Strength, safety, interchangeability, flexibility and "rollability" are the oustanding features claimed for Yale steel-plate trolleys.

Locomotive Hoist with Individual Motor Drive

TWO interesting developments in screw jack locomotive and car hoists, recently brought out by the Whiting Corporation, Harvey, Ill., are shown in the illustrations.

The locomotive hoist, shown in Fig. 1, is similar in design to the standard Whiting locomotive hoist which has proven valuable in unwheeling and wheeling locomotives in railroad shops. The main difference is that each jack is operated by a small individual motor, mounted on the jack unit, with one spur gear reduction between the motor and hoist worm. This eliminates all line shafting, line shaft bearings, bevel gears, etc. It also simplifies the construction of the pit and reduces erection expense materially.

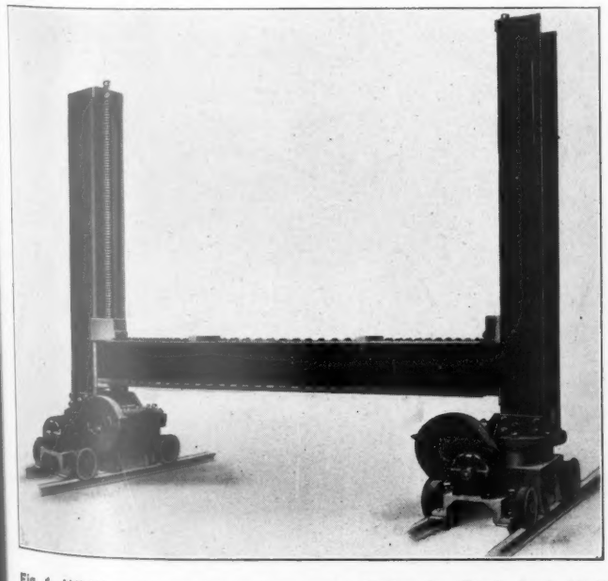


Fig. 1—Whiting Locomotive Hoist with Motor for Each Jack Unit

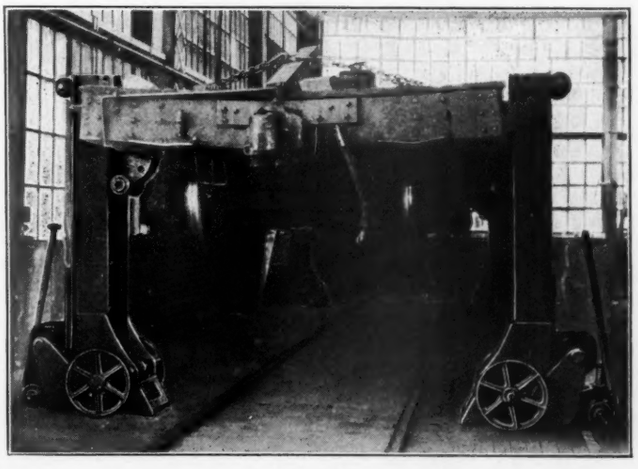


Fig. 2—Portable Screw Jack for Lifting Freight Cars and Coaches

Each motor is provided with a control panel which allows adjustment of any one of the jack nuts. In handling a lo-

comotive all four jacks are operated by a master switch. Separate switches may also be used to control the jacks in pairs. The movable jack is carried on four wheels which normally carry the jack slightly above the rails. As soon as a load is applied to the jack, the coil springs under the axle bearings are compressed slightly and the main frame of the jack is grounded securely on the rails.

This type of hoist may consist of one pair of movable jacks and one pair of stationary jacks, of two pairs of movable jacks, or of other combinations, including three or more pairs of jacks.

Fig. 2 shows a portable screw jack hoist designed to handle coaches or freight cars of any size or weight. No special foundation is required, although the flooring on either side of the track should be level and capable of sustaining the loads.

This hoist also employs the screw jack principle of design. The body of the car rests directly on a substantial step supported by rollers on both sides of the I-beam columns and resting on the bronze nut. The screw is driven by a large worm gear resting on a heavy roller thrust bearing. Each jack is driven by its own motor through a silent chain drive. When hoisting, each jack is completely grounded, the base of the jack extending in well under the step and the wheels relieved of their load.

Whenever it is desired to move the jack, the hoist nut is lowered, depressing the forked lever, which raises the jack clear of the ground. When this position is reached, the current is cut off from the motor by the limit switch. The jack is moved from place to place by the long tongue attached to the small front truck. This truck swivels under the jack base, allowing the operator to turn in very close quarters.

Spiral-Fluted Boiler Staybolt Tap

A STAYBOLT TAP, designed for long life and having special construction and operation features, has been developed and patented by W. L. Brubaker & Brothers Company, Millersburg, Pa. In producing this tap Brubaker engineers utilized the vast amount of data on boiler staybolt tapping collected over the period of nearly forty years in which this company has been active in attempting to eliminate the troubles common to staybolt taps.

After the design was completed, taps were put in use in shops all over the world and tested through a period of three years, in order to determine the value of the tap in service. The results obtained indicated that the new tap had a decided advantage over any tap that the Brubaker Company has made prior to this time.

Due to the special taper with which the tap is designed, the life of the tap, as nearly as can be determined from tests, has been increased about 20 per cent. This taper is so designed that it distributes the work along the entire length of the tap, thus making each part of the tap perform the same amount of work as every other portion. At high speeds, it is claimed that vibration is very greatly reduced, thus permitting more holes per day to be tapped and decreasing the man power required to hold the tap in place while in operation.

The tap has a free cutting edge and it has been found that the motor speed can be increased without injuring the tap, because of the reduced friction. The results of overheating taps are too well known to require comment. By reducing friction, the heat generated during the tapping operation is decreased and consequently the dulling action which takes place when the heat softens the tap in spots. Reducing friction also brings about a saving in power.

This tap has a special standardized relief which is uniform for every tap. It is a combined machine and hand relief. Another feature of the tap is that it is made of a special steel having a composition that gives long life and eliminates breakage under ordinary service conditions. The tap is specially tempered so that it is kept within the lead tolerances after machining, and so that the cutting quality is in no way impaired. The temper is standard for all taps giving a proper cutting quality and a soft center.

Brubaker Spiral-Fluted Staybolt Tap in Action

The new Brubaker staybolt tap is made in all styles and to meet all tapping requirements.

New Method of Flexible Staybolt Inspection

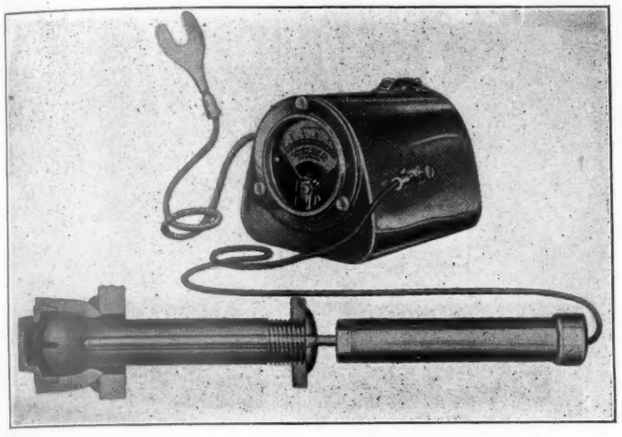
AS far back as 1916 a method of testing flexible staybolts was developed by the Flannery Bolt Company, Pittsburgh, Pa. At that time, however, the method had not progressed beyond the experimental stage and it has taken seven years to bring the method to its present state of perfection. Actual locomotive service tests covering the past three years are said to have demonstrated that the method as now developed is a positive means of determining the conditions of flexible staybolts in service.

No method of testing that depends upon the human element should be satisfactory where danger to human life is concerned, and innumerable reports can be produced to prove the uncertainty and inefficiency of present methods. This point is substantiated by an article published on page 174 of the March issue of the *Railway Mechanical Engineer* in which the author says: "In my opinion, in going over a boiler on a staybolt test, the inspector cannot get all the broken and cracked bolts."

The human element is practically eliminated by the new method of inspection which requires no change in the

standard parts of a flexible staybolt assemblage with the exception of providing a bolt with a tell-tale hole extending from the inner end into, but not through, the head of the bolt.

Inspection is accomplished by establishing electrical contact at the extreme inner end of the tell-tale hole by means of a device consisting of a meter, batteries, an indicating



Flannery Equipment for Testing Flexible Staybolts

rod and connection to the boiler. The apparatus is simple and compact and requires no particular care except the occasional renewal of a dry cell battery.

Reference to the illustration will indicate how the tester works. The connection to the boiler may be made at any point where good contact can be secured and the indicating rod is inserted in the tell-tale hole. As soon as the tip of the rod has reached the end of the tell-tale hole, the electric circuit is completed and is registered on the meter, thus insuring the tell-tale hole being open its full length and properly functioning. If the indicator rod is stopped before the meter indicates contact, this shows the hole to be obstructed in some manner. In this event, the hole is cleaned by means of a drill and small motor until contact can be established.

The method of testing is simple and there is no phase of the test that depends upon the human element, except the simple act of inserting the testing rod into the tell-tale hole. If the bolt is fractured, this will appear in the hydrostatic test which is applied after electrical contact has been made with all the bolts. The tell-tale holes being clean will immediately indicate a fracture by water leakage from a bolt that is defective.

To insure clean tell-tale holes a fireproof, easily removable, porous cement is provided to seal the end of the tell-tale hole after the bolts are installed and riveted. Occasionally a mechanic may neglect to seal a hollow Tate bolt with the porous cement and in that event a small drill should be used to bore out the tell-tale hole preliminary to inserting the testing rod for inspection of the stay bolt.

If the tell-tale hole has been sealed with the porous cement, sediment or any other obstruction that would prevent contact between the testing rod and the end of the tell-tale hole can only come from a fractured bolt. This will be readily indicated when the hole is cleaned and when the hydrostatic test is applied.

Recent Developments in Coated Abrasives

RECENT developments in the coated abrasive industry make it now possible for the master painter to secure better work, lower sanding and rubbing costs, and better satisfied workmen, by means of scientifically developed sandpapers and cloths. In the following paragraphs are outlined several of the more recent developments in sandpapers by the Manning Abrasive Company, Inc., Troy, N. Y.

Waterproof speed-grits, placed on the market last September, are primarily designed for water sanding on painting materials where speed of operation and fine finish are wanted. The coating of the grit side is thoroughly waterproof so that even soaking the paper in water for a period of hours will not cause the grit to shed or come off. The backings are of a high-grade Manila rope paper, medium in weight and sufficiently waterproof to resist wear, yet not slippery or hard to handle.

The grit used for coating Waterproof speed-grits is a pure, artificial abrasive made in the electric furnace. It is hard and tough, yet not excessively sharp, and while designed to cut rapidly the hardest and toughest of painting materials, it also produces a fine commercial finish. Waterproof speed-grits are made in seven grit sizes: Nos. 120, 150, 180, 220, 240, 280 to 320 the latter being very fine. Tests are said to have proven conclusively that these papers for water sanding will outcut the rubbing brick and pumice, and at the same time produce the desired finish; also their use does not require a great amount of experience in order to secure satisfactory production and finish. This is a feature of importance.

Surfacing materials (putty, etc.) can be well and quickly smoothed with waterproof speed-grits; also varnishes and enamels requiring much labor to surface with pumice and water. Little or no rubbing slush is created, eliminating much of the usual clean-up time necessary with the pumice method.

The High-Speed Coating

Another development is the high-speed coating with cutting grits so placed on the backing as to allow for chip clearance. In other words, the grits are not heavily piled on the sheet, but placed with spaces or clearances between each cutting grain. This method of coating is something

Operation of Water Rubbing on Varnish

new in the coated abrasive industry, and the development was the outgrowth of a demand for a paper that would not rapidly load or ball on the cutting face. Garnet and artificial papers are made with the high-speed coating, the grits covering a wide range from coarse to very fine. The back-

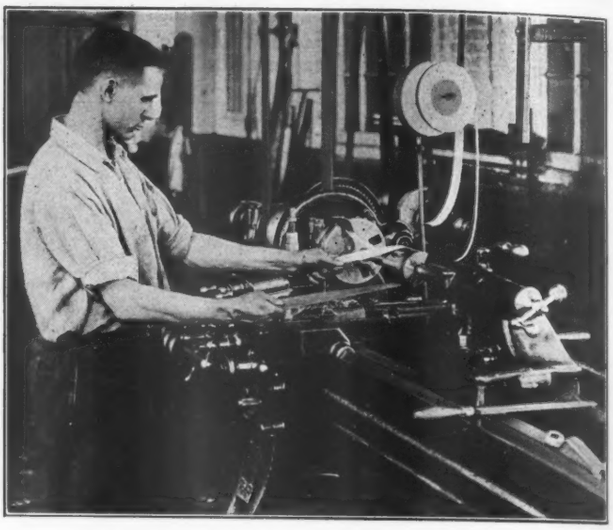
ings range from light finishing papers to the heavier roll stock.

High-speed papers load down into the sheet, and, until all the clearance spaces are filled, there is little tendency for heavy loading or balling on top of the cutting face of the paper. This is a marked advantage in dry or oil sanding. The open coating gives to the sheet extreme flexibility, which on many operations is a desirable factor. With the high-speed coatings, it is also possible to place the grit on the backing in such a manner that the maximum number of the grits' sharp edges are standing up and exposed for cutting. This feature gives the high-speed coatings very fast cutting action.

Speed-grits papers with high-speed coating are especially well adapted for sanding surfacing materials, varnishes and enamels, and where this work is being done on a production basis, the performance of these new coatings will prove most interesting.

Metal Working Abrasive Cloths

In railroad shops abrasive cloths are used for many surfacing and polishing operations on metal. There have been two important improvements in products for this work. First, emery has been largely replaced with Metalite, a pure, hard, tough and sharp electric furnace abrasive. Second, Metalite products are now available in a wider range of backings than heretofore. Flexible Metalite is a comparatively light weight, soft, pliable, limp sheet, for work which has a number of difficult places to reach. Ream Metalite is another type, a medium weight product well adapted for general all-around work. Roll or X-Metalite is a stiff, heavy backed product used for the heavier machine operations, such as belt and disc sanding.

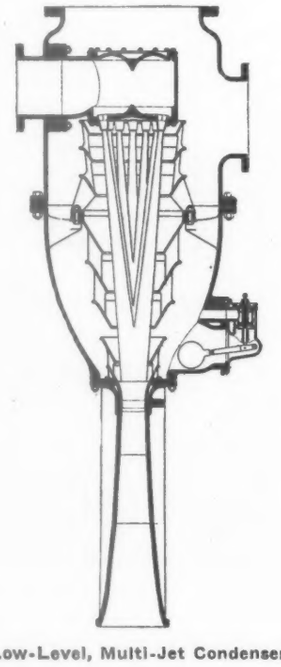


Abrasive Cloth Used for Surfacing Operation

While Metalite is slightly higher in first cost than emery, it is claimed that this difference is more than offset by the additional production and longer working life of the product.

Jet Condenser for Power Stations

CONDENSERS are ordinarily divided into two classes, (a) surface condensers in which the exhaust steam and the cooling water are separated by metallic heat transmitting surface, and (b) jet condensers in which the steam is brought into direct contact with the cooling water and condensed: And the condensate, water, air and non-condensible gases are removed either by gravity, by so-called air pumps and removal pumps, or by means of the kinetic energy of the cooling water.



Low-Level, Multi-Jet Condenser

The selection of the proper condenser is a comparatively simple matter and depends essentially upon the quantity and quality of the cooling water available. If the supply is abundant, and if the water is suitable for boiler feeding purposes, the best condenser to install is a jet condenser. This is the cheapest both in first cost and maintenance charges.

The jet condenser should also be used in instances where the condensing water is suitable for boiler feeding, but where the supply is limited and comparatively expensive to obtain a recooling system should be installed whereby the warm condensing water from the hotwell can be recooled sufficiently and used over and over again.

If the condensing water is unsuitable for boiler feed, then a surface condenser must be used. This is so whether the supply of water is abundant or limited. A water purifying system or evaporator is ordinarily used if the make-up water is to be taken from the cooling water supply. Furthermore a recooling system is installed in instances where the supply of water is comparatively difficult and expensive to obtain.

A type of jet condenser, known as a low-level multi-jet condenser has been developed by Schutte & Koerting, Philadelphia, Pa., as shown in the illustration. It has several outstanding features, the principal one of which is that the condensed steam, water, non-condensible gases and air are discharged from the condenser by the ejector action of the water jets. Air pumps and so-called removal pumps are entirely dispensed with. Since the centrifugal injection water pump delivers the water to the condenser under pressure it can be designed for low or moderate suction lift and therefore operates at high efficiency.

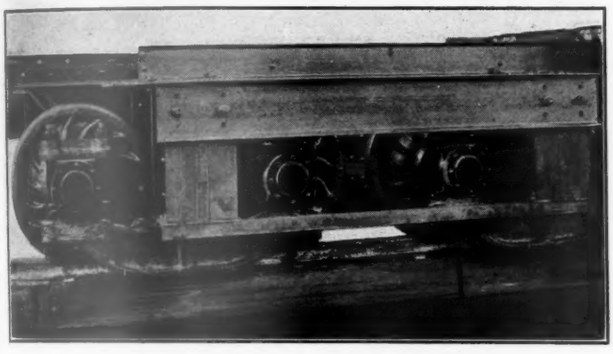
The condenser consists essentially of a cylindrical casing, a water nozzle case, a combining tube, and a tail pipe or diffuser. The sectional cut shows these parts. Both top and side steam inlets are provided either of which may be used. The injection water is delivered into the water nozzle case at about 9 lb. pressure (equivalent to 21 ft. of water column), whereupon it is discharged through the several nozzles, passed through the combining tube where it is brought into contact with the steam, and finally discharged through the tail pipe into the hotwell. The steam is drawn through the annular passages between the tapering rings constituting the combining tube, and condensed by the water jets. The condensate together with the air and non-condensible gases is removed by means of the kinetic energy of the water jets. The condenser acts to create the vacuum by condensing the exhaust steam and maintains it by removing the condensate, together with the air and gases.

The multi-jet condenser is built in 30 standard sizes for steam units ranging from 100 kw. capacity to 10,000 kw. capacity. Single condensers are used up to 5,000 kw. and twin arrangements for larger units. The largest single multi-jet condenser built to date is designed to handle 14,000 gals. of water a minute. This condenser has a 66 in. top steam inlet, 30 in. water connection, is 18½ ft. high and 8 ft. in diameter and weighs about 11 tons.

Turntable Rolling Resistance Reduced 50 Per Cent

AN 85-ft. twin-span turntable equipped with Stafford roller bearings has recently been built by the Dominion Bridge Company, Montreal, Canada, for the Canadian National Railways.

Judging from experimental and service tests, the use of properly designed roller bearings for car journals reduces



Turntable Equipped with Stafford Roller Bearings

journal resistance 90 per cent with a resultant saving of 25 to 50 per cent in train resistance and a corresponding saving in fuel used for motive power. Turntable resistance can be reduced in practically the same proportion by the use of roller bearings, and in the turntable, illustrated, it has been found possible to use a motor of only 15 hp., whereas a similar turntable equipped with standard friction type journal bearings would require a 30-hp. motor for satisfactory operation. This shows that the power saving may run as high as 50 per cent.

Turntables are not in constant operation. They are subject to exposure variations of temperature, snow and water, and it has been found necessary at some points to encircle the pits with steam lines in order to keep turntables in satisfactory operation during cold weather. Even where heating is installed for the purpose of keeping the pit clear of snow and ice, the roller bearings will still be of very decided advantage. If roller bearings were subject to freezing as journal friction bearings are, a 15-hp. motor would not be sufficient to take care of cold weather conditions, but since roller bearings do not freeze, practically no more power is required for winter than for summer operation. Oil application is required at very infrequent intervals, possibly once in three to five years, which means a saving in maintenance costs.

The bearings on the turntable illustrated are Stafford roller bearings, 5-in. by 9-in. in size, which are subjected to a 48,000 lb. impact load per bearing when a locomotive comes on to the table. The ability of these bearings to carry such a tremendous load is due to their special design. The rollers are in two races, staggered and this design eliminates the continual raising of the load as each roller approaches the crown of the bearing.

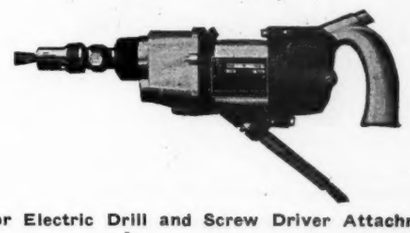
The definite results already shown in the use of this type of bearing have resulted in several steam and electric installations, and many other installations are under contemplation.

Screw Driving on Rapid Production Basis

DRIVING screws has always been more or less of a problem, as the common methods by which screws are driven in wood or metal have invariably slowed down production. To overcome this difficulty the engineers of the Independent Pneumatic Tool Company, Chicago, Ill. have developed and perfected a device for the rapid driving of screws in production work. This device, known as the Thor screw driver attachment, is fastened to the spindle end of a small size portable electric drill, which has a speed suitable for driving not only wood screws, but also cap screws and any other machine screws. It will drive screws of all sizes, a No. 6 or a No. 18 wood screw equally as well, with one size attachment. Above the No. 18 screw, a heavier attachment is used. It has been demonstrated in various shops that any man, without special mechanical ability, can after short practice drive 50 to 60 ordinary No. 14 wood screws a minute.

In construction the Thor screw driver is simple, consisting of but two units. The first unit, or body, is connected to the drill spindle and revolves at all times when the drill is running. The second unit is the part that holds the screw driver bit. This has a long sliding bearing which fits into a similar sized hole in the body. Each unit has a shoulder, milled so as to form a dog clutch. The clutch is engaged, forming the driver, by a light pressure of the operator's hand, and is disengaged by a coil spring in the back end of the body. When screws or bolts are drawn up tight, the clutch will automatically release. The screw driver bits are held in a square hole and can be removed by simply pulling out a flat spring which is concealed and out of the way when the bit is held in the attachment.

The Thor screw driver attachment is also made with a bell shaped or self-centering finder, and with this type it is not even necessary for the operator to place the bit in the screw



Thor Electric Drill and Screw Driver Attachment

head slot, as by placing the bell finder over the screw head, the bit will automatically find the slot. This also prevents the screw driver bit from sliding off the screw as it is likely to do when grease or oil is used around it.

The Thor screw driver attachment is well adapted for use in freight and passenger car shops, and in fact wherever there are screws, nuts, studs, or anything having threads to drive.

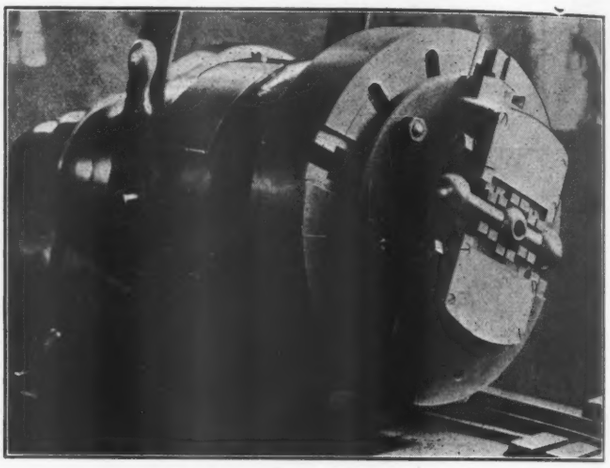
The Thor electric drill with screw driver attachment is in reality a several purpose machine, as the screw driver attachment can be removed in a few seconds, and replaced with a drill chuck, or other attachment so that the same electric drill may be used for drilling, reaming, woodboring, and similar operations.

Universal Vise of Interesting Design

FALSE jaws, split vise chucks, clamps and bolts and in many cases jigs and special settings, used in chucking irregular shapes, are made unnecessary by the new universal vise illustrated. This device, of Swiss manufacture and sold by Bruce, Dawson & Company, London, E. C. 2, England, will with a single movement firmly grip any work no matter how irregular its shape. Owing to the fact that the work is gripped all over, it is held securely so that it can be subjected to severe action in any machine tool without danger of the work loosening.

The manipulation of this device is simple and it can be used as readily by an unskilled as a skilled mechanic. Referring to the illustration it will be noted that the vise contains a number of jaws, all of which enter into operation automatically at the same time simply through the action of turning the handle. The jaws, subjected to individual spring action, are tightened up until they touch the piece all over or at least at a sufficient number of points. After this the two large nuts on the sides are tightened so that the relative position of the loose jaws becomes fixed. The piece is then fully tightened by a turn of the vise handle. All similar parts can afterwards be gripped by a half turn of the handle. If work with machined faces or faces which can easily be damaged has to be secured, these faces are protected by cardboard or similar material.

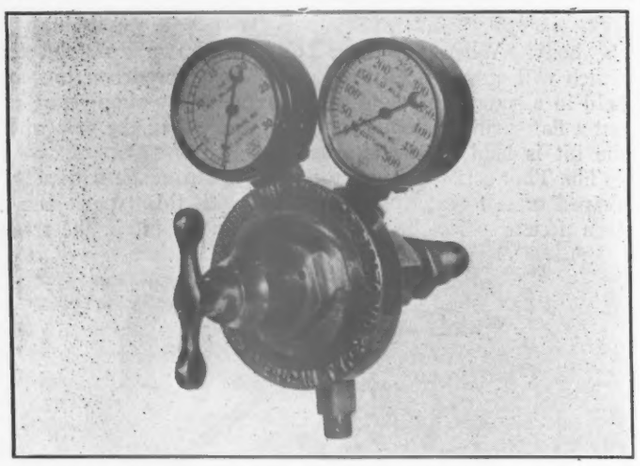
This universal vise can be bolted direct to the bed, table, or slide of any standard machine tool, in exactly the same way as an ordinary vise. The vise is supplied in three different types, *A* with a rectangular base for use in all classes of machine tools, *B* as shown in the illustration for use on lathes and *C*, which is a special attachment to a bench vise.



Swiss-Made Vise for Gripping Irregular Work

Regulator for High Pressure Gases

THE American type regulator, illustrated, is for the control and delivery of acetylene, oxygen, hydrogen, and other high pressure gases in gas cutting and welding operations. The regulator maintains a constant, predetermined pressure regardless of fluctuations in the initial high pressure line and variations in consumption at the torch.



Alexander Milburn High Pressure Gas Regulator

The regulator comprises a front cap, containing an adjusting key, top spring button and tension spring. The body contains in front a flexible metal diaphragm, soldered on. Over the diaphragm is screwed a bronze diaphragm plate or spring button to hold the tension spring. Inside the body is a fixed nozzle, containing a loose operating pin. Over the nozzle is loosely assembled the valve sleeve which has a row of gas ports drilled around its circumference and carries the valve seat. The seat closes against the nozzle.

The loose operating pin inside the nozzle is actuated at one end by depression of the diaphragm and at the other end by pressure of the valve seat. The seat of the regulator closes with instead of against the pressure and this enables the seating to be effected by a small pressure. The closing of the seat is independent of the diaphragm.

A perfect balance or equilibrium of pressure is maintained at all times in the regulator, throttling the supply when the desired pressure is built up, and instantly responding with increased supply when consuming requirements lower the delivery pressure.

The main operating part, comprising only a pin and nozzle and a seat-carrying sleeve, is almost immediately accessible for examination, cleaning or renewal.

By improved design the regulator is simplified in every particular and reduced in size and weight. The valve seat is subject to much less wear or chance of damage, and, being held in perfect alinement, it tends to retain its accuracy many months longer than the seat of an old-style regulator.

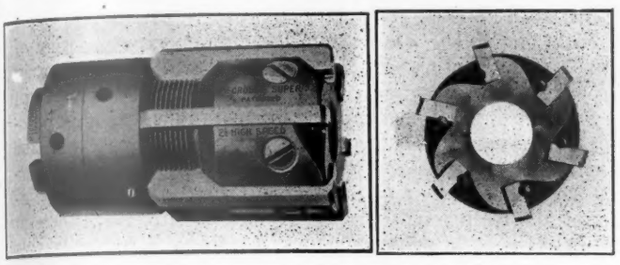
Neither volume of gas nor accuracy of regulation is sacrificed by the simple construction. On the contrary, the regulator acts with more directness and regulates within closer limits. By the mere change of the gages and the rear connection the regulator is immediately adapted to the various gases and types of containers for same.

This regulator was invented by A. F. Jenkins, and is manufactured and sold by the Alexander Milburn Company, Baltimore, Md.

Adjustable Reamer with Valuable New Features

THE ability of McCrosky-Super reamers made by the McCrosky Tool Corp., Meadville, Pa., to ream holes accurately and economically has been strengthened by two important improvements as follows:

(1) The McCrosky design for clearance and support. By this design the reamer body in front of the cutting edge of each blade has been relieved to provide ample space for chip clearance and lubrication. This feature removes any possibility of chips clogging along the cutting edge of the blade. This clearance makes it possible to shorten the projection of the blades over the end of the reamer body, consequently more support is provided back of the blade where it is needed. Thus, the design gives at once extra clearance and support.



McCrosky Adjustable Reamer with Two Important Improvements

(2) The reamer body is hardened all over. This feature increases the resistance of the reamer to hard usage and prolongs the life of the body, permitting many sets of new blades to be inserted in the original body.

These improvements are additions to the other well-known features such as forward adjustment, large range of adjustment, simplicity of construction, and the patented McCrosky locking device.

Calorac Portable Electric Rivet Heaters

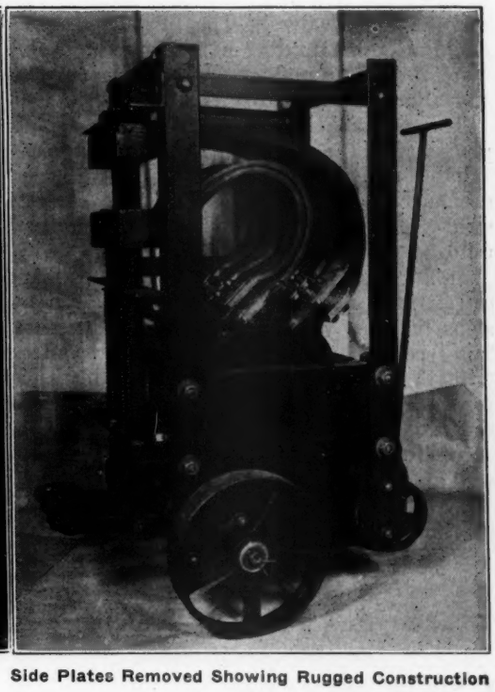
THE latest types of electric rivet heaters, manufactured by the Humil Corporation, New York, have a number of distinctive features, the most important of these being flexibility in operation, permitting the efficient heating of a wide range of sizes without the usual burning of the smaller rivets on machines of the higher ratings, and at the same time permitting the heating for non-continuous service of the largest rivets on the smallest machines.

Low power consumption, or high efficiency, has been secured by generous proportioning of copper and iron in the special type transformer, also by heavy cross sections in the long flexible leads that are autogeneously welded into the pure copper electrodes or heads. This latter arrangement marks a radical departure from previous practice in that the contacts and leads can be readily renewed without disassembling the machine. Their length and high flexibility are such as to permit operation at the foot pedals at between 10 and 15 lb. pressure, thus avoiding the tiring effort of pressing against a heavy spring and preventing squashing or upsetting the ends of the rivets being heated.

Regulation against heavy power surges on starting the heating action, and the maintenance of high power factors (79 to 94), are obtained by means of air gaps in the transformer magnetic circuit. The high efficiency and power factor is also maintained through placing the transformer low in the machine and remote from the radiated and conducted heat from the rivets. Air spaces, provided between the coils, permit a constant stream of cold air to pass up through the transformer, cooling it constantly and enabling it to maintain high efficiency under continuous full load.

All of the coils are positioned around a separate center core, the secondary coils of heavy cast copper completely enclosing the core, except for a small gap at the top to provide the open circuit necessary. This design provides for

Calorac 3-Head Portable Rivet Heater on Boiler Work



Side Plates Removed Showing Rugged Construction

the complete cutting of all magnetic lines by both primary and secondary coils. The primary coils are wound with bare strip copper, insulated with asbestos and mica tape. This provides for rapid dissipation of the heat to the vertical air spaces and at the same time eliminates high voltage between layers of windings.

Stability and portability are secured in the Calorac heaters by keeping the center of gravity low in the frame and mounting the machine on large traction wheels. Provision has also been made for lifting by crane.

Close regulation of the power applied to the rivets is obtained by a five-speed controller, so mounted as to be readily accessible to the operator, thus permitting him to govern his production rate accurately. On the smallest two-contact Type A-2-H machine, rivets ¼ in. by 1 in. can be heated at the rate of 720 per hour, while in the same machine rivets ⅝ in. by 2¼ in. are said to have been heated at the rate of 150 per hour. This same machine is also capable of heating much larger rivets. The large Type C heaters, when equipped with three or five sets of heating contacts, are capable of reaching a high production of hot rivets of the largest sizes. These machines are well adapted to heating the large mudring rivets used in locomotive boilers.

Rivets heated by this process are hotter at the cores than on the outside, as the heat is generated within the rivets themselves, and consequently it follows that they hold their heat considerably longer than rivets heated by external application methods. The avoidance of currents of oxidizing gases produces rivets free from scale, and this, with the hotter and more plastic central zones characteristic of rivets heated by this process, ensures faster, tighter, and cleaner riveting with less chance of loose rivets.

Referring to the illustration, the simple, rugged design of this heater is apparent. Hard usage with small expense for up-keep were prime considerations in its design. Built entirely of steel, iron, copper, asbestos and mica, it is practically fire-proof. Heavy impregnation of all coils with the highest grade of insulating varnish render this heater waterproof as well. Safety of the operator is secured by the shielding of all live primary parts, while the electromotive force at the heads is so low that it cannot be felt by bare hands, this voltage never exceeding 3 volts. The machine is designed to be fool-proof and fire-proof. The comfort of the operator as well as that of other men in the shop is assured by the absence of smoke and fumes, with a resultant favorable effect on output.

Small Direct-Connected Air Compressor

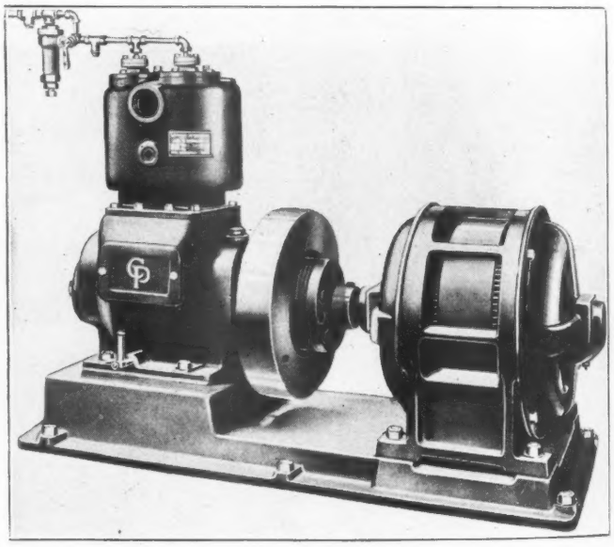
A SMALL air compressor which can be run at high speed and direct connected to an electric motor or internal combustion engine, has recently been developed by the Chicago Pneumatic Tool Company, New York, as shown in the illustration.

The compressor is of the vertical, duplex, single-acting, water-cooled type and is fitted with Simplate flat disk inlet and discharge valves. The lift of these valves is straight and uniform, affording a maximum of valve area, thereby increasing the speed at which the compressor may operate and allowing the use of direct drive.

The machine is built in three sizes, having piston displacements of 128, 160 and 210 cu. ft. per min. Each is suitable for working pressures of 150 lb. per sq. in. and is designed to run at a speed of 600 r.p.m. Standard equipment includes a hand starter for the motor and an inlet valve unloader for the compressor.

If an intermittent supply of air is demanded, the motor can be furnished with an automatic starter which starts and stops the unit within predetermined pressure limits. With this type of starter, the compressor is equipped with a centrifugal unloader which automatically relieves the compressor of its load while the motor is starting up or shutting down. This condition is said to be essential to the successful operation of an automatically controlled compressor.

A water control valve is also furnished, which is operated by air pressure governed by the centrifugal unloader. Since the lubrication is accomplished by a combination pump and splash system, the complete unit is automatic in every detail, as it controls the electric current, air delivered, circulating water and lubrication.



Direct-Connected High Speed Air Compressor

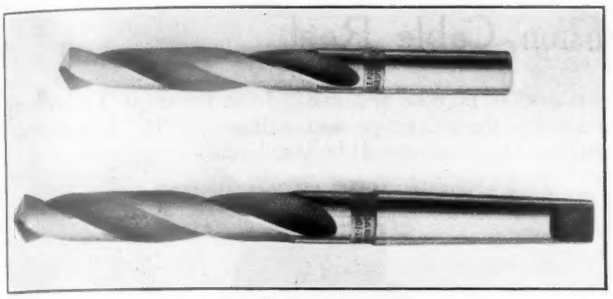
A New Development in Drill Making

FOR the past few years high speed drills have been made by two methods, first, by twisting a flat bar, or second, by milling from a round bar. The first involves a hot working process to form the flutes, followed in turn by a machining and a twisting process, or by a simple twisting process without the machining. In both cases the web is usually not central and efforts are made to return it to the correct position by a straightening process, a flute grinding process, or by both.

In spite of the additional toughness imparted to the drill by these methods, the second type of drill made from the full round bar by the milling process, has continued to be the one made and sold in largest quantities, and therefore the one most suitable to the general requirements of the metal-working industry.

The continued preponderance of the milled type of drill may therefore be attributed to the fact that the webs of such drills are centrally located by the milling machine. The drills are uniform and will therefore drill more uniform holes.

The drill point grinding machine insures that points of drills are ground correctly, and such machines should be in more general use than they are. This machine is, however, only a machine and can grind correctly only such drills as are made accurately and uniformly. If the web of a drill is



Cle-forge Drills Designed to Combine Toughness and Accuracy

not central, the point of the drill cannot be accurately ground in a point grinding machine. Drills with the web off center can be ground out at the point so as to bring the web central at that place, but this is a more skilled operation than point grinding by hand and it is one which is seldom, if ever, well done in the average machine shop.

It therefore follows that the ideal twist drill is one having the toughness of the hot-worked drill and the accuracy of the milled drill. It enables drills to be properly ground by machine and assists in removing the prejudice which apparently exists among mechanics against using these machines.

As a large manufacturer of both milled and forged drills the Cleveland Twist Drill Company, Cleveland, Ohio, has been experimenting with a view to placing on the market a single drill which would embody the advantages known to be possessed in part by the forged drill and in part by the milled drill. A process, said to accomplish this result, has been perfected and given the trade name Cle-forge. Cle-forge drills are hot worked where necessary to impart toughness and are afterward machined in the same manner as a milled drill. In fact they cannot be distinguished from the former milled product by mechanical inspection. Briefly, Cle-forge drills are intended to unite in one tool all the advantages of both forged and milled drills so that their cutting quality and strength will surpass that of any former type of forged drill and their accuracy be equal to that of the milled drill.

Portable Bar for Reboring Air Cylinders

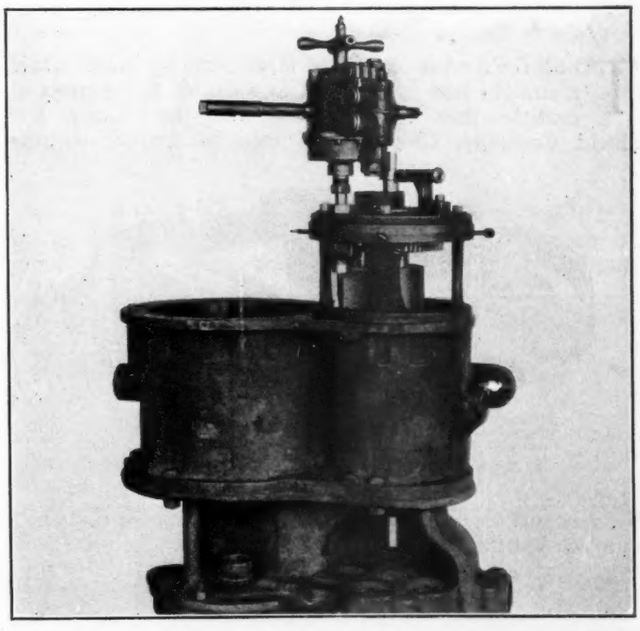
THE latest development in the line of portable tools made for railroad shop use by H. B. Underwood & Company, Philadelphia, Pa., is the portable boring bar equipment, illustrated. This equipment is used for reboring locomotive air compressor cylinders and pump cylinders used in railroad shops and power plants. In the former case cylinders can be bored in the repair shop, or without removing the air compressor from the locomotive, an important advantage. Due to its light weight and compactness the equipment can be used in close quarters.

This boring bar equipment is notable for rugged construction, accuracy, simplicity of design, involving few parts, adaptability to limited spaces, and the ease and speed of setting up and operating. The bearing plate carries a boring bar driving spindle and feed screw, mounted on a clamping ring, and a cutterhead. The pilot guide is screwed on the stuffing box and the bar placed in the cylinder, a clamping ring being securely fastened to the top flange of the cylinder by studs and nuts. Any inaccuracy in the position of the studs in the cylinder flange is readily overcome by means of the four thumb screws for accurately alining the bar. The tool is adjusted and rigidly held in the cutterhead by tightening the collar screw, which clamps the tool to the cutterhead by means of a simple and substantial tool clamp; the tool may be as readily released when the cutterhead is at the lower end of the cylinder, when it is so desired.

In boring cylinders to a certain diameter the use of calipers is entirely dispensed with. By means of a gage, furnished with each bar, a simple and practical method of setting the tool to the required position is used. In this manner a number of cylinders can be bored to accurate dimensions without loss of time due to regrinding tools, etc.

The driving spindle is provided with a Morse taper shank to fit the air motor and drives a pinion which meshes with a gear keyed to the boring bar, providing a simple and efficient drive. Keyed to the feed screw is a feed gear which meshes with a reverse gear journaled on a pin centered in the boring bar; the reverse gear turns freely on this pin unless prevented by the feed pawl being engaged, which holds the reverse gear stationary relative to the bar and causes the feed gear to revolve the feed screw and advance the cutterhead into the work. To return the cutterhead to the top of cylinder the air motor is placed on the shank of the reverse gear which rapidly returns the cutterhead.

Reboring both ends of a 9½ Westinghouse air pump ac-



Underwood Boring Bar Set Up to Bore High Pressure Air Cylinder

curately to size with this equipment is said to have been done in the following actual time:

Setting up on steam end	7 min.
Reboring time	16 min.
Setting up on air cylinder	8 min.
Reboring air cylinder	15 min.
Removing machine	7 min.
Total time	60 min.

This tool is regularly made in sizes suitable for reboring

cylinder and bushings of standard air compressors and may be readily adopted to other sizes by changing the cutterheads.

The weight of an equipment of this character with capacity to bore from 8½ in. to 11 in. in diameter by 12 in. stroke without air motor is approximately 140 lb.; for the compound compressors 8½ in. to 14½ in. by 12 in. stroke, the device weighs about 200 lb.

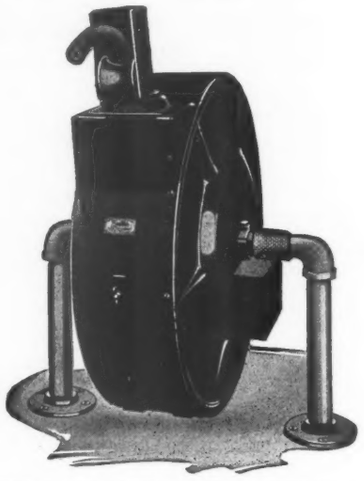
Heavy-Duty Extension Cable Reel

THE heavy-duty Reelite, recently developed by the Appleton Electric Company, Chicago, is a self-contained device for paying out and automatically retrieving electric conductors for power and light. It is especially adapted for machinery requiring a varying length of cable. This will permit operation of the machinery at any distance within a radius equal to the length of cable contained in the reel. An important advantage of this device is the protection to the cable which is thereby afforded a long life free from service interruptions for cable repairs.

Among the machines with which this device can be used may be listed cranes, dredges, magnets, electric motor buckets, etc. It can also be used extensively in foundries, blacksmith, machine and car shops, and electric welding shops.

The device is furnished without brackets but with 1-in. male-threaded hubs so that it is easily adaptable to any requirement. The power cable is connected to it by means of heavy brushes operating on commutators. The wire is connected to the commutators, eliminating wear and tear on connectors and always insuring a perfect contact.

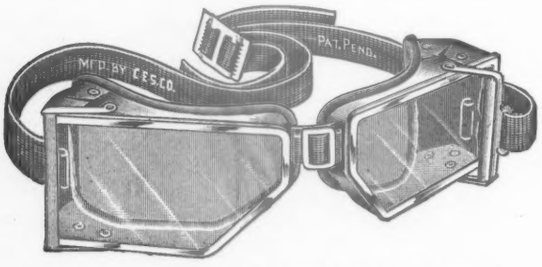
The heavy-duty Reelite can be furnished in various widths, all of the same diameter and with two or three wire commutators, as may be required. In ordering, it is necessary to specify the amperage and voltage so that proper commutators and brushes will be installed.



Reelite Protects the Cable, Giving Uninterrupted Service

Wide Vision Straight Lens Goggles

TO fill the need in shops and manufacturing plants where a straight lens is preferred to ward off flying rivets or particles that will strike the lens, the Chicago Eye Shield Company, Chicago, has recently brought out the



Straight Lens Goggles Providing Wide Vision

No. 224 goggles illustrated. These goggles can be furnished with non-shattering lenses which will multiply the protection where the danger is unusually great. The fit is readily adjusted to any wearer by the buckle adjustment at the bridge. Lenses will not fall out of the frame as they are double locked by a special end but they are easily interchangeable at will. The frames are made of non-corrosive white metal darkened on the inside to prevent glare. They are regularly furnished bound in heavy rubber which gives the greatest satisfaction.

Some grinders and industrial workers who need protection against dust or flying chips prefer cup goggles. The No. 505 S goggles made by the Chicago Eye Shield Company are of this type, being provided with unusually shallow cups, which allow a wide range of vision. An adjustable nose bridge assures a fit best adapted to each wearer and the safety flange gives protection in the event that the lens should be broken, as it can not be pushed back into the eye. These lenses also can be readily interchanged through the screw top. The heavy rubber binding used is comfortable and gives a maximum or sanitary protection. These goggles can be furnished with colored lenses for use in welding.

Regulator for Oxygen and Acetylene Gas

THE Torchweld Equipment Company, Chicago, has produced a new style of regulator for holding a constant back pressure with oxyacetylene cutting and welding equipment. This regulator is sturdy throughout, and an important improvement is the arrangement for the regulator seats or diaphragms to be easily replaced when necessary by the operator without sending the regulator to the manufacturer for attention.

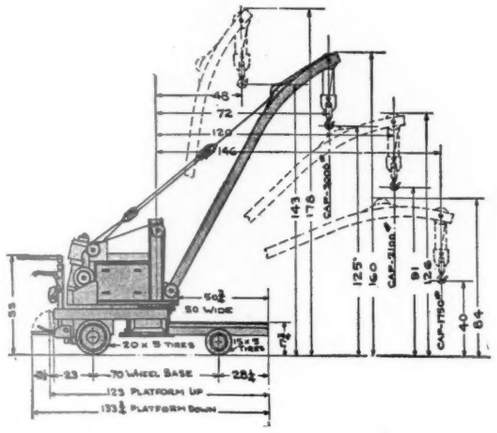
The construction is such that the regulator holds a constant pressure and does not fluctuate when the valves are closed, the back pressure in the regulator body itself not exceeding 2½ to 3 lb. due to the improved construction. Welding regulators are 3 in. in diameter; cutting regulators, 2½ in.; and regulators for lead burning purposes, 2 in. An important point in the construction of this regulator is the provision of three diaphragms of graduated sizes, enabling

the regulator to control gas pressures properly. The diaphragms are not soldered to the regulator body but are held in position by means of bonnet screws.

Regulator leakage has heretofore been due in many instances to gas leaking through the nozzle and past the seat but the Torchweld construction provides for the yoke, holding the regulator seat, to slide over the nozzle itself thereby keeping the nozzle and seat in accurate alinement at all times which prevents improper functioning of a regulator due to vibrations or shock.

Crane Truck with Power-Swiveling Attachment

UNUSUAL interest attaches to the new three-way crane truck made by the Baker R. & L. Company, Cleveland, Ohio, owing to the power swiveling attachment. This feature greatly increases the utility of the machine and



Proportions and Lifting Capacity of Baker 3-Way Crane

enables the driver to operate it with far less exertion and accomplish more work in a given time. Another feature of importance is the double drum hoist. This hoist is driven by a single motor, the power being applied to either drum by means of magnetically operated friction clutches. This makes the change from one drum to the other very smooth, and the construction is such that the drum which is not working is firmly held by a large-sized brake.

On the Baker three-way crane truck illustrated two-wheel drive and four-wheel steer is provided, the capacity being as indicated in the illustration. The traveling speed without load is 530 ft. per min. or 6 miles per hour and with a rated load of 3,000 lb., 395 ft. per min. or 4½ miles per hour. The new load hoisting speed is 30 ft. per min. and with a rated load of 3,000 lb. the hook rises 7 ft. per min. Three speeds forward and reverse are obtainable by means of the controller which is of the continuous tongue drum type, totally enclosed.

The slewing unit is pillar mounted and turns on ball bearings. A worm and spur gear, reduction unit, transmits power from the slewing motor, provided with a magnetic brake. The slewing motor is compound wound, totally enclosed, operating at 24 volts and 32 amperes with a speed of 1,700 r.p.m. It has a high overload capacity. Control of the slewing motor is by means of a drum-type reversing controller mounted on the dash. Limit switches are provided, positive in action and automatically controlling the hoisting and reverse motions of the boom, hoisting motion of the load hoist and slewing motion. The boom is fabricated from structural steel and can be made to any length required within reasonable limits.

Push and Pull Traveling Cranes

IMPROVED push and pull traveling cranes, in capacities of 1,000 lb. and 2,000 lb., have been placed on the market recently by the Louden Machinery Company, Fairfield, Ia. The bridge consists of two rolled steel channels set back to back, with track hangers bolted rigidly between them. The ends of the channels rest on the malleable iron end trucks to which they are securely fastened by bolts.

Each end truck is a single certified malleable iron casting, with both ends forked to straddle the track wheels, thereby providing bearings on both sides of the wheels. The track wheels are gray iron and deeply flanged, the end truck projecting down to within a half inch of the runway track. It is practically impossible to throw the crane off the track, but even if it should be thrown off, it cannot drop more than ½ in. without resting directly upon the rails. In no case would the entire crane fall and endanger the workmen underneath.

The operation of these cranes is easy under light or heavy loads, a slight push or pull being sufficient to move them. Eight Hyatt roller bearings are used, one on each side of each wheel, in dust-proof housings, fitted with compression grease cups. Louden end trucks also are specially designed for 1,000-lb. and 2,000-lb. loads and in this respect are different from many other light cranes which merely have light bridges, but use the same heavy end trucks designed for cranes of larger capacity.

Spans for the 1,000-lb. crane are available up to 20 ft.; for the 2,000-lb. crane, span up to 30 ft. (The span is figured from center to center of the T rails.) The head

Louden Push and Pull Cranes in Foundry

room is 19⅝ in. on 1,000-lb. cranes; 21⅝ in. on 2,000-lb. cranes.

Ample safety factors are used, being from 4 to 8. The

cranes can be connected up with any number of off-running overhead carrying system tracks, from either side of the craneway. The crane is latched into alinement with the connecting track by a positive type of latch. When latched into position the crane cannot be moved away until a chain is pulled to unlatch it. Should the latch be thrown in when the crane is not close to alinement, the crane automatically throws the latch out as it passes. The method of alining these Louden cranes is designed to be positive, prevent accidents and make possible a quick connection.

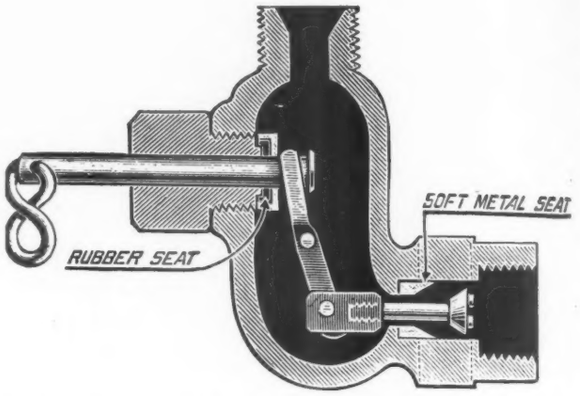
Safety Valve for Gas Welding Apparatus

DESIGNED to safeguard the welder, and reduce fire hazards and losses, the safety valve illustrated has been developed recently by the Mattingly Automatic Valve Company, St. Louis, Mo. This valve is applicable to oxyacetylene welding and cutting outfits, being applied between the hose and the gas tanks. It closes instantly and automatically in case the hose line becomes ruptured or disconnected, thereby preventing the escape of gas and the danger of fires or personal injuries to the welders.

This safety valve does not in any way interfere with the operation of the torch or regulator and one of its most important advantages is the feeling of security given to the welder. The regular stock valve is made to work on any outfit using hose lines from 10 to 60 ft. in length. These valves will not always give the best results on longer lines and special valves can be provided for any length of hose that may be specified.

Referring to the illustration, the operation of this valve will be evident. It consists of a right-angle body, the valve and soft metal seat at the right being next to the regulator. (The upper connection is to the hose.) This valve is connected through a pivoted lever to the stem extending to the left. In operation the stem is pulled to the left until pressure is built in the hose line thereby holding the valve open. It is obvious that should the hose become ruptured or disconnected, the pressure will suddenly drop in the right angle body when the rush of gas from the tank will close the valve against its soft metal seat.

A feature of the Mattingly safety valve is the absence of any packing. The escape of gas around the stem when the valve is open is prevented by a soft rubber-seated valve which seats against the cone-shaped bushing through which it operates. The rubber may be removed as often as necessary by simply unscrewing the bushing which allows the stem to be lifted out and a new rubber replaced. This prevents the escape of gas.



Mattingly Valve Designed to Increase Safety of Gas Welding Operations

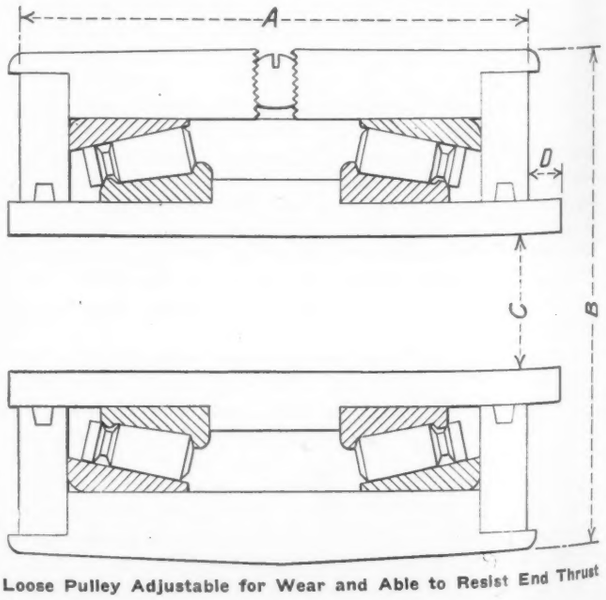
Loose Pulley with Taper Roller Bearings

WITH the purpose of providing a loose pulley which should be practically frictionless, have provision for taking end thrust and also afford a long life, the St. Louis Machine Tool Company, St. Louis, Mo., has developed the pulley shown in the drawing. The objection to the old type straight roller bearing was the absence of provision for wear adjustment and end thrust and in the case of ball bearings, the cost has been high in addition to the structural disadvantage of the large outside diameter in relation to the bore. This eliminated them from use in arbor pulleys on many high-speed machines where the pulleys are necessarily small.

The comparatively recent advent of the adjustable taper roller bearing with provision for taking end thrust largely overcomes these difficulties. The races can be so thin that loose pulleys as small as 2½ in. in diameter can be made by mounting the bearings directly on the shaft. It is preferable, however, to mount them on a sleeve as shown in the illustration. Where this construction can be used, it is often possible to save the old and worn shafts or arbors which are sometimes worth as much as the pulley and in some cases more.

Pulleys of the type illustrated are being supplied by the St. Louis Machine Tool Company for replacement of all kinds of machinery, any size from 2½ in. to 22 in. in diameter being available. Hanger boxes in countershafts can also be equipped with these bearings to advantage.

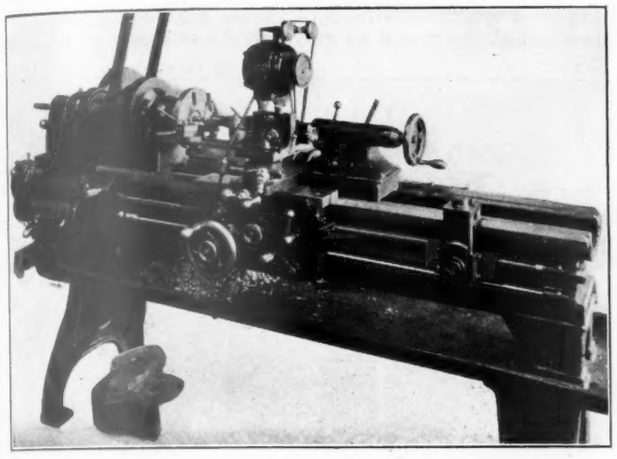
The design and location of loose pulleys has an important effect on machine efficiency and belt wear, and the provision of a loose pulley with taper roller bearings adjustable for wear, as illustrated, should prove decidedly helpful in solving any loose pulley problem presented to railroad men.



Loose Pulley Adjustable for Wear and Able to Resist End Thrust

Precision Grinder and Thread Lead Variator

IMPORTANT features of the 1923 model multi-graduated Precision thread grinder made by the Precision & Thread Grinder Manufacturing Company, Philadelphia, Pa., include a redesigned spindle, improved index, dust cap and oiling devices.



Multi-Graduated Precision Grinder and Thread Lead Variator Used on Toolroom Lathe

The spindle and driving pulleys are machined in one piece from solid stock of special heat-treated alloy steel. This eliminates lost motion or slippage due to loose pulleys. The rear bearing is so constructed that should there be any elongation of the spindle due to increased temperature, it is subject to floating, thereby eliminating any extra duty on the bearings. The new spindle is heavier and more sturdily built and has many advantages over the old construction. Norma ball bearings are used, as formerly.

A ¼-hp. motor, fully enclosed, ball bearing, statically and dynamically balanced, is now furnished. This motor eliminates all possibility of chattering. An improved index for setting the helix angle with larger graduations has been installed on the grinder. Ball bearings are furnished in the idler pulleys. A dust cap is now supplied on the grinder which precludes all dust, grit, etc., from entering the spindle housing. Improved oiling devices have also been installed.

The illustration shows a multi-graduated Precision grinder and thread lead variator installed on a 14-in. by 6-ft. toolroom lathe. This lead-variating device is used for obtaining precision lead from the ordinary lathe lead screw; also to elongate the lead on parts which are subsequently to be hardened to compensate for the approximate shrinkage in lead, eliminating correction grinding in non-precision work and reducing the correction grinding necessary in precision work, such as thread gages, taps, hobs, dies, chases, etc. Metric threads and any threads of odd or unusual lead may be cut by the use of the variator without requiring special or translating gears.

Three New Westinghouse Products

DURING the past year, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed several heaters of the type illustrated in Fig. 1, to be used for heating offices, shops, watchman's shanties, etc. They are safe, neat in appearance and convenient. They are not affected by varying gas, pressures and can be installed in the most desirable location without regard to steam or gas lines. The heat is easily regulated by means of a convenient three-heat switch. The cost of installing this form of heating apparatus is much less than that of most other forms and the operating cost is relatively low.

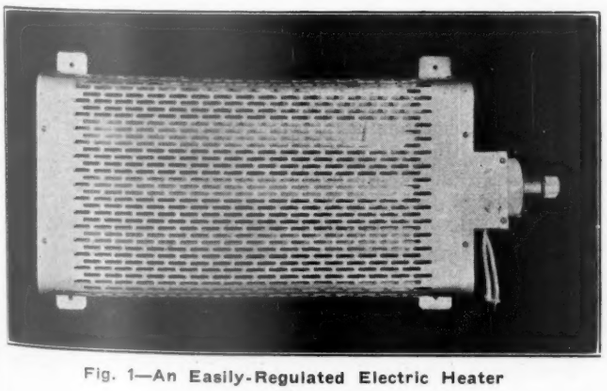


Fig. 1—An Easily-Regulated Electric Heater

Westinghouse electric glue pots (Fig. 2) are light, sturdy and safe. They may be used for heating materials with low melting points such as paraffin, beeswax, etc., as well as glue. They are being used in many industries where the features of safety, convenience, dependability and uniformity of operating conditions are important. They are of the dry type to eliminate the danger of boiling dry and burning out the heating element, the inconvenience and sloppiness of constantly refilling the water bath, and to reduce the amount of current used in operating the pot.

The most important feature of the new electrically-heated solder pot (not illustrated) is convenience, combined with the elimination of the fire hazard. Westinghouse small electrically heated solder pots are made in 10 and 30 lb. sizes and may be used to heat solder, babbitt, battery compound and other materials having a low melting point. They are equipped with three-heat switches, which permit the solder to be quickly melted on the high heating rate and kept at the proper temperature on a lower rate, without further attention. They are built to withstand hard usage and be dependable in operation. The heating chamber is thoroughly insulated, making the pot economical in operation and comfortable to work around.

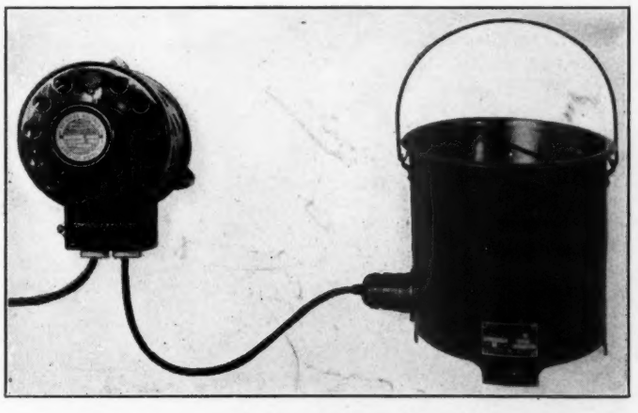


Fig. 2—Convenient Melting Pot for Glue, Paraffin, etc.

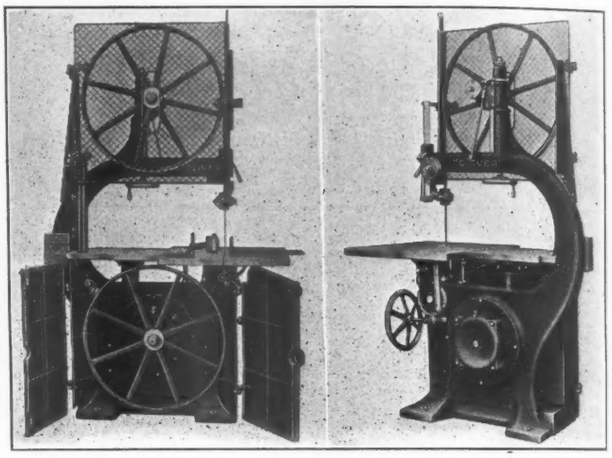
Band Saw with Direct Motor Drive

SIMPLICITY, fewer parts and increased efficiency usually result from the application of direct motor drive to machine tools and with the idea of benefiting to the fullest possible extent from these advantages the Oliver Machinery Company, Grand Rapids, Mich., has provided direct motor drive for many of its woodworking machines as described in recent issues of the *Railway Mechanical Engineer*.

Referring to the illustration, the method of applying direct motor drive to the Oliver No. 16 band saw will be evident from the two views. The rotor of the driving motor is keyed to the lower wheel shaft which runs in two ball bearings supported by the two end bells. These end bells have finished concentric tongues which fit accurately inside the finished rings of the band saw frame as well as the stator, assuring accurate alinement and easy accessibility. This is a simple and efficient construction, the band saw taking up little floor space and having few moving parts, which tends to reduce vibration to a minimum. The motor is fully enclosed but by means of the air gap running up into the column there is sufficient circulation of air within the enclosure to keep the motor cool.

The lower wheel has a positive non-changing alinement with the frame of the machine. The upper wheel has a simple 12-in. vertical screw adjustment for tensioning the saw and an unusual delicate micrometer screw-tilting device for tracking the saw on the wheel. All adjustments are controlled by hand wheels. The guides are of the frictionless roller type, one above and the other below the table. The saw runs against the outer edge of a hardened wheel, which is arranged to revolve against a ball bearing. The hardened steel side guides or lips are adjustable to prevent turning the saw sidewise.

An important feature of any band saw is the method of safeguarding the operator. Two safety guards are provided in this case, one at the rear, U-shaped, made of wood and one at the front L-shaped, made of steel with wood facing. These guards cover the blade at all points except the part doing the sawing between the guide and table. The lower wheel is encased by two iron doors preventing danger

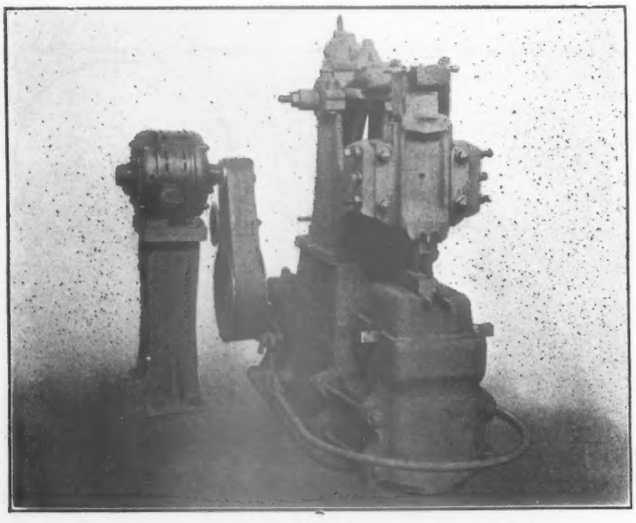


Oliver No. 16 Band Saw with Direct Motor Drive

to the operator and confining the saw dust to a limited area. The upper wheel is covered by a heavy wire mesh door or guard, supported on a cast-iron hinged bracket attached to the column of the machine and locked with a spring clasp. The band saw table is of cast-iron 36 in. by 30 in. and 40 in. high. From three to five horsepower is required to drive this machine, depending on the work.

New Motor Drive for Helve Hammers

THE style of electric motor drive for upright helve hammers, made by C. C. Bradley & Son, Inc., Syracuse, N. Y., and described on page 232 of the June, 1922, *Railway Mechanical Engineer*, has been recently changed to



Bradley Helve Hammer With New Motor Drive

that shown in the illustration. In the original design, the hammers were arranged with the idler head of the driving pulley and the motor set on a block two or three inches above the floor base. The constant revolution of the motor pulley on the drive belt caused the belt to heat and burn and require frequent replacement. This difficulty has been overcome by installing the idler back of the drive and the motor in such a way as to allow the hammer to run as if the belt were connected to a countershaft, this construction being clearly shown in the illustration.

Nine sizes of electric motor are used on Bradley upright helve hammers, from 1½ hp. for the 30-lb. hammer to 15 hp. for the 500-lb. hammer. On one of the intermediate sizes, the 125-lb. hammer, for example, a 5-hp. motor is used running at 1,200 r.p.m., the speed of the hammer being 350 r.p.m. This hammer is fitted to handle 2-in. stock.

THE SOUTH AFRICAN RAILWAYS have just awarded to the Natal By-Products, Ltd., manufacturers of "Natalite," a gasoline substitute, a six months' contract for motor fuel for use throughout their motor transport service, according to a report to the Department of Commerce. Natalite, which is a sugar cane distillate made largely from waste material, will be supplied to the South African Railways at one shilling four pence per imperial gallon (26.7 cents per U. S. gallon) free on rail at Mearbank, near Durban. It is understood that this is about one-third under the lowest bid for gasoline. The producers of Natalite claim that their product is 90 per cent efficient as compared with gasoline, and it is evident that even discounting this figure, the substitute must be reckoned with in the future. This is the first large contract that has been secured by any gasoline substitute, and the outcome of the trial will be awaited with interest.

GENERAL NEWS

The machine shops of the Esquimalt & Nanaimo at Wellington, Vancouver Island, were completely destroyed by fire on April 30. The loss is estimated at $80,000.

Pay Increase on the P. R. R.

The Pennsylvania has made a general increase in the pay of employees at the Altoona shops, said to amount to three cents an hour. The increase is retroactive to May 1, and piece-workers as well as other employees are advanced, the estimated total number of men affected at Altoona being 10,000.

Power Brake Investigation Reopened

The Interstate Commerce Commission has ordered that its investigation of power brakes and appliances, on which weeks of hearings were held and on which the arguments were submitted some time ago, be reopened for the purpose of a test by the commission of the brake of the Automatic Straight Air Brake Company upon the Norfolk & Western.

Credit to the Southern and Southwestern Railway Club

On page 275 of the May, 1923, issue of the *Railway Mechanical Engineer*, there appeared an article entitled "Locomotive Boiler Water Circulation," by Mr. C. A. Seley, consulting engineer, Locomotive Firebox Company. This article is an abstract of a paper which Mr. Seley read before the March meeting of the Southern and Southwestern Railway Club at Atlanta, Ga. Through an oversight, proper acknowledgment as to its source was omitted at the time it was published.

Wage Statistics for February

The number of employees reported by Class I roads for the month of February, 1923, was 1,783,555, an increase of 4,039, or 0.2 per cent, as compared with the returns for January, 1923, according to the Interstate Commerce Commission's monthly summary of wage statistics. The total compensation was $230,416,541, a decrease of $19,635,245, or 7.9 per cent. This decrease in compensation, notwithstanding the increase in employment, is explained by the fact that February had only 23 working days while January had 26.

Railroads in New York City Limits Required to Electrify by 1926

Governor Smith has signed the act which has been passed by the legislature requiring the substitution of electric for steam locomotives within the city limits by 1926. The roads most seriously affected under the act are the New York Central, The New York, New Haven & Hartford, the Baltimore & Ohio and the Long Island. Two or three other roads which operate steam switching locomotives at their New York piers are also affected to some degree.

Large Railway Repair Shop in Southern France

The locomotive and railway rolling-stock construction and repair shops located near Marseilles in 1919 by the Chantiers et Ateliers de la Capellette comprise the most important industry established in the south of France since the war. The plant covers about 32 acres and has, in addition to a large diversity of factory buildings and sheds and about 7½ miles of track. The shops are equipped to repair 400 railway carriages at a time, and one building, 255 ft. by 575 ft., is able to handle 36 locomotives simultaneously. A large number of electric traveling cranes, some having a capacity of 60 tons, are in use; the entire equipment is said to be complete and modern in every way. Much of the repair work of the Paris, Lyons & Mediterranean Railway and of the Midi Railway, as well as that of the smaller local lines, is handled by this plant.

A. F. of L. Shop Craft Workers Seek Increases

Railroad shopmen belonging to or affiliated with the American Federation of Labor have sent notices to a number of prominent roads proposing a general increase of pay because of the increased cost of living; the application being based also on an assertion that men in similar classes of work outside the railroad service are now receiving rates which justify the request for an increase. The first road concerning which this notice was made public was the Pittsburgh & Lake Erie, but it appears that the leaders intend to make the same request on all roads which settled last summer's strike with the brotherhoods.

Austrian Locomotive Industry Thrives

Recent orders for locomotives from Yugoslavia, Rumania, and Hungary, in addition to those of the Austrian State Railways, are sufficient to keep the Austrian locomotive factories busy for some time, according to the Neues Wiener Journal, as reported by Consul Weingartner at Vienna.

The Austrian government has ordered 17 electric locomotives for the Arlberg and Salzkammergut railways. The Italian State Railways have placed an order in Austria for 200 locomotives to be delivered within 3 years. The Neue Freie Presse reports this to be the first order of Italian State Railways placed outside of Italy.

Locomotive Conditions in April Best Since July, 1922

Interstate Commerce Commission's monthly report to the President is the best since July, 1922. In April 5,266 locomotives were inspected by the Bureau of Locomotive Inspection, of which 3,049, or 58 per cent, were found defective and 511 were ordered out of service. The percentage of those inspected found defective is the lowest that has been reported for any month since the shopmen's strike began last July. For the months of August, September and October, 1922, the percentage was 71. During the same month (April) 96,940 freight cars were inspected by the Bureau of Safety, of which 7.3 per cent were found defective and 1,983 passenger cars, of which 1 per cent were found defective. In April, 1922, 4½ per cent of the freight cars inspected were found defective and 0.9 per cent of the passenger cars.

Arbitration Courts to Deal with Labor Matters in Argentina

The Argentine government has issued several decrees providing for the constitution of arbitration courts which are to deal with all questions arising between railways and their employees, and specifically, with the claims of the shop employees to an annual vacation of eight days on full pay. The railway companies have presented on their part a joint memorial to the Minister of Public Works objecting to the proposed arbitration procedure—alike in the case at issue and as a general principle—on the ground that it is unconstitutional. The companies in the concluding portion of their memorial quote recent utterances by the present Minister of the Interior, formerly Solicitor General. The Minister, Doctor Matienzo, replying a few weeks ago to a question in the Chamber of Deputies said that the decrees governing the matter were not at all in accord with the law.

Proposed Locomotives for Australia

The new chief commissioner of railways in South Australia (W. A. Webb), after giving attention to the haulage capacity of the State's locomotives, has written to the leading English, Scottish, Australian and American builders, asking them for suggestions for new types of locomotives, more particularly of the following classes: Mountain type passenger locomotive with tractive force of 41,000 lb. to 43,000 lb.; Pacific type passenger locomotive with tractive force of 32,000 lb. to 35,000 lb.; Mikado type freight engine,

50,000 lb. to 55,000 lb. tractive force; Decapod type freight engine, 60,000 lb. to 65,000 lb. tractive force, and Santa Fe type engine, about 60,000 lb. tractive force. The most powerful locomotive running in South Australia at present has a tractive force of 20,000 lb. The commissioner says that tenders for the proposed new types are not being called at present, but on receipt of suggestions from locomotive builders requests will be placed for definite designs.

Students in Central of Georgia Shops

Students of the Georgia School of Technology, Atlanta, Ga., will be able henceforth to earn their way through school. By an arrangement between the school and the Central of Georgia Railway the student will be enrolled in what is known as the "Co-operative Plan of Engineering," and will alternate between four weeks of classroom work and four weeks in the Central of Georgia shops. The "co-operative plan" leads to graduation in five years, instead of the usual four years. The railway pays the students 30 cents an hour upon entrance, and this is increased at each six-month period throughout the five years. The student apprentices are regular employees of the railway and are entitled to transportation, group life insurance, pension benefits and other features that make employment with the Central attractive. Young men who reside in the cities where the Central has shops may spend half of their time at their homes, during their college course, and their earnings will be sufficient to pay their expenses at school during the time they are on the campus.

Shop Wage Negotiations in Britain

The British railway companies have modified their shop wage reduction proposals to the unions to provide for a 2s. ($.50) per week reduction immediately and an additional reduction of 1s. ($.25) a week during the following month. The proposal so far has been presented only to the shop craft unions and not to the National Union of Railwaymen.

The shop craft unions are the regular metal trades unions, and include both railway shopmen and mechanics from outside industries in their membership. The National Union of Railwaymen is an industrial union which "caters" to all classes of railway employees. The shopmen are about equally divided in their affiliation with the craft unions and the N. U. R.

The purpose of the proposed wage reduction is to reduce the operating expenses of the railways so that further decreases in freight and passenger rates may be possible. The wages of metal trades workers in other industries are 6s. 6d. ($1.60) lower than those of men doing similar work for the railways.

Chaining Standing Cars Is Not a "Coupling" Within the Law

A car with a defective coupler was waiting with others on a dead track for transfer to the repair shop, attached to the next car by a chain. A foreman of car inspectors, passing, went between the cars to shorten the chain, without setting out a flag, as the rules required. The movement of another car on the track caused a collision, resulting in his death. The Circuit Court of Appeals, Sixth Circuit, holds that the proximate cause of death was the failure to set out the flag, and not the defective coupler, and the company was not liable under section 4 of the Safety Appliance Act.

To chain together two cars which have stood for hours and may stand for hours more untouched upon a track unused save as a receiving station for the car hospital is of course, in a certain broad sense, to "couple" them; but the word usually describes the operation which accompanies the approach of one car to the other. A crushing impact is the expected incident of the normal coupling, and safeguards are constantly necessary; not so, necessarily of a "coupling" which calls for no impact.—McCalmont v. Pennsylvania, 283 Fed. 736.

Group Life Insurance on the Central of Georgia

The Central of Georgia Railway has adopted an arrangement under which its skilled employees may avail themselves of group life insurance at low rates. The amount is to be based upon the employees' annual pay from a minimum of $1,000 to a maximum of $3,000. Provision is made for compensation in cases of permanent disability. The premium to be paid by the employee is 60 cents per month per thousand of insurance. The remainder of the premium is paid by the railway company.

This is in addition to the pension system, the benefits of which the company extends without cost to the employee. President William A. Winburn, in a circular announcing the scheme to employees says:

"These matters are apart from the underlying desire of the company to provide continuous employment at fair compensation. Thought is given at all times toward making conditions surrounding work for this company safe and comfortable. These are some of the things that make work for the Central of Georgia attractive. The task of providing dependable transportation for the public is one of dignity and importance. It offers interest, opportunity, and compensation to those engaged in it. I feel sure that all of you in the service take pride in your work. You need have no hesitation in letting the public know of your reasons for this pride in your calling and in your company."

Earliest Locomotive in America Traced

Wholly lost sight of for nearly a hundred years and with its fate still unrecorded in detail, the first steam locomotive ever seen on the American continent has within a few weeks past been traced by one of its members, the right-hand cylinder, which has just been authoritatively identified in the National Museum at Washington. This locomotive, the "America," was built in 1828 on an order from the Delaware and Hudson Canal Company by George Stephenson of England, who soon after designed and built the famous Rocket, and was in nearly all respects, except that it did not have the multitubular boiler, the pattern for the more famous engine.

The "America" was brought to New York by the Delaware and Hudson Company in January, 1829, and after being demonstrated under steam was sent up the company's new canal towards Honesdale, where it was to be tried out on the first railroad in the country, connecting Honesdale and Carbondale. From the time the "America" passed the eastern terminus of the canal all documentary record of it ceases. But a few weeks ago an official of the Delaware and Hudson Company, while arranging with the National Museum at Washington for the loan of a model of the "Stourbridge Lion," another Delaware and Hudson locomotive, which was the first to be tested on a railroad track in America, found among the unmounted locomotive parts which had been supposed to belong to the "Lion," a cylinder whose design and measurements showed it beyond question to be one of the cylinders of the missing locomotive "America." Curator C. W. Mitman, of the division of Mechanical Technology of the Museum, declared, after a careful comparison of this cylinder with historical data, that the identification could not be questioned. It is hoped that with this clue established, other parts of the "America" may be recovered, as the "Stourbridge Lion" itself has been gradually re-assembled in nearly all parts, from various sources along the lines of the Delaware and Hudson Company.

MEETINGS AND CONVENTIONS

Program for American Society for Testing Materials

The American Society for Testing Materials will hold its 26th annual meeting at the Chalfonte-Haddon Hall, Atlantic City, N. J., on June 25-29. Because of the increased volume of reports and papers to come before this meeting, 13 sessions have been arranged beginning on Monday evening and closing on Friday evening.

General Foremen's Convention

A program of topics for discussion at the 1923 convention of the International Railway General Foremen's Association, which will be held at the Hotel Sherman, Chicago, September 4-7, has been arranged as follows: Topic No. 1—Shop Efficiency, Locomotive and Car Departments—(a) Apprentices, Training and Developing; (b) Relation of Foremen and Employees; (c) Methods of Increasing Efficiency of Supervisors and Employees; (d) Discipline; (e) Increased Output per Man Hour. Topic No. 2—Costs—General Repair Methods and Maintenance of Valves, Valve

Gears and Power Reverse Gears; (b) Engine, Tender and Car Trucks; (c) Air Brake Appliances on Passenger and Freight Equipment; Topic No. 3—General Repair Methods and Maintenance of Stokers, Coal Pushers and Air Firedoors; Topic No. 4—Shop Kinks, Locomotive and Car Departments; Subsidiary Topic No. 1—Welding Flanges on Driving Tires, Engine Truck and Tender Wheel Tires.

Annual Meeting of C. I. C. I. & C. F. A.

The Chief Interchange Car Inspectors' and Car Foremen's Association has selected October 3, 4 and 5 as the dates for the annual meeting which will be held at the Hotel Sherman, Chicago. It is planned to have the papers by A. J. Mitchener and W. J. Owen, which were awarded the prizes in the *Railway Mechanical Engineer's* competition on car inspection read at this meeting. Further details of the program will be announced later.

New Officers of Canadian Railway Club

At the annual meeting of the Canadian Railway Club at Montreal on May 8 the following officers were elected: H. R. Naylor, assistant works manager, Angus shops, C. P. R., president; C. E. Brooks, chief of motive power, C. N. R., first vice-president; J. A. Shaw, general electric engineer, C. P. R., second vice-president; W. A. Booth, chief draughtsman, mechanical department, C. N. R., secretary; and P. C. Reynolds, chief clerk to chief of motive power, C. P. R., treasurer.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—C. Borcherdt, 202 North Hamilton Ave., Chicago.

AMERICAN RAILWAY ASSOCIATION, DIVISION V—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Annual meeting, Orchestra Hall, 220 South Michigan Ave., Chicago, beginning June 20, 1923.

DIVISION V—EQUIPMENT PAINTING DIVISION.—V. R. Hawthorne, Chicago.

DIVISION VI—PURCASES AND STORES.—W. J. Farrell, 30 Vesey St., New York.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 30 Church St., New York.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, Chalfonte-Haddon Hall Hotels, Atlantic City, N. J., beginning June 25, 1923.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Eastern sectional meeting June 14 and 15, Bethlehem, Pa.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

CANADIAN RAILWAY CLUB.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meetings second Tuesday in each month, except June, July and August at Windsor Hotel, Montreal.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting monthly, Hotel Iroquois, Buffalo, N. Y.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual meeting, Hotel Sherman, Chicago, October 3, 4 and 5.

CINCINNATI RAILWAY CLUB.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings second Tuesday, February, May, September and November.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash Ave., Winona, Minn. Annual convention, Hotel Sherman, Chicago, September 4-7, 1923.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meetings second Tuesday in each month, except June, July, August and September, Copley-Plaza Hotel.

NEW YORK RAILWAY CLUB.—H. D. Vought, 26 6Cortlandt St., New York. Meeting third Friday of each month except June, July and August at 29 West Thirty-ninth street, New York.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in each month, except June, July and August.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday each month, except June, July and August.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

WESTERN RAILWAY CLUB.—Bruce V. Crandall, 605 North Michigan Ave., Chicago. Meetings third Monday in each month, except June, July and August.

SUPPLY TRADE NOTES

The Whitman & Barnes Manufacturing Company has moved its New York office to 99 Chambers street.

The Link Belt Company, Chicago, will construct a one-story machine shop 125 by 135 ft. to cost approximately $85,000.

The Locomotive Lubricator Company has moved its offices from 6 North Michigan avenue, Chicago, to 2443 Sheffield avenue.

Elisha H. Talbot, retired publisher and founder of the Railway Age, died at his home in New York on May 22 at the age of 83.

The Jones & Laughlin Steel Corporation has purchased 319 acres of land near Hammond, Ind., on which a plant will be constructed.

The Nathan Manufacturing Company, New York, has removed its Chicago office from 707 Great Northern building to 14 East Jackson boulevard.

The American Car & Foundry Company will construct a one-story assembly building at 2416 South Paulina street, Chicago, at an approximate cost of $100,000.

H. E. Reynolds has been appointed district manager of the Pittsburgh, Pa., office at 1222 Fulton building of the Whiting Corporation, to succeed S. C. Wilson.

E. A. Thornwell, Candler building, Atlanta, Ga., has been appointed sales representative of the Edgewater Steel Company, Pittsburgh, Pa., vice John Hyland, deceased.

W. B. Fraser, one of the partners in the Coale-Fraser Lumber Company, Lytton building, Chicago, has assumed charge of the company's West Coast office, Tacoma, Washington.

The National Lumber Manufacturers' Association of Chicago has removed its office from the Harris Trust building to 2017 Conway building, 111 W. Washington street, Chicago.

The Morton Manufacturing Company, Chicago, manufacturers of railway appliances, is building an addition to its Chicago factory which will give 18,000 sq. ft. of additional floor space.

Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, of New York and Ampere, N. J., died suddenly on April 21, at his home in New York City.

Charles B. Yardley, who formerly represented Jenkins Brothers, New York, with all railroads in its New York distributing district, will again become railroad representative for the same district.

The Daniel Woodhead Company, Chicago, representatives for fans, lighting units for electrical departments and Keller pneumatic tools and reflectors, has moved its offices to 15 North Jefferson street.

The Gibb Instrument Company, Bay City, Mich., manufacturers of electric welding equipment, have been appointed distributors of the General Electric Company's arc welding electrodes in the middle west.

H. B. Doerr, chief mechanical engineer of the Scullin Steel Company, with headquarters at St. Louis, Mo., has been promoted to general superintendent, succeeding L. C. Perry, resigned to engage in private business.

W. C. Thatcher, assistant superintendent of construction of the National Boiler Washing Company, with headquarters at Chicago, has been promoted to general superintendent of construction, succeeding J. M. Weir, resigned.

S. W. Hall, chief material inspector of the New York Central, with headquarters at Cleveland, Ohio, has resigned to become a representative of the railroad department of the Wolf Brush Company, with headquarters at Chicago.

Poultney Gorter, heretofore in the contracting department and various other departments at the shops of the Pullman Company, has been appointed assistant to the eastern sales manager of the Pullman Company, 25 Broadway, New York City.

The Detroit Steel Products Company, Detroit, Mich., will establish a branch factory at Emeryville, Cal., which will have 83,000 sq. ft. of space. A. Lum has been appointed manager of the plant and will have charge of sales on the Pacific Coast.

J. H. Cross., formerly western manager of the service department of the Railway Age and allied publications and later advertising representative for these publications, died on May 22. In 1918 Mr. Cross left these publications to form an advertising agency.

R. W. Wentworth has been appointed district manager of sales of the Interstate Iron & Steel Company, with headquarters in the Merchants National Bank building, St. Paul, Minn. The company was formerly represented in the Northwest by the Paul J. Kaulman Steel Company.

Paul Llewellyn, vice-president and general sales manager of the bar division of the Interstate Iron & Steel Company, with headquarters at Chicago, has been promoted to vice-president in charge of all sales, with the same headquarters, and will be succeeded by H. F. Schroeder, representative at New York.

The Texas Company, Houston, Tex., has organized a western sales department, with headquarters at Denver, Colo., and established stations and other marketing equipment throughout the new territory. Fred W. Freeman has been appointed general western manager and H. W. Dodge has been appointed western sales manager.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has removed its Pittsburgh, Pa., office of the Central district from the Farmers Bank building to rooms 950 to 953 Century building, on Seventh street between Penn avenue and Duquesne way. A. G. Pierce is manager of the Central district, with headquarters in Pittsburgh.

Harry S. C. Folk and Donald Weaver have joined the railway department of the Electric Storage Battery Company as assistants to Howard S. Mills of the New York City office. Mr. Folk was previously in charge of the industrial truck and locomotive department and Mr. Weaver was formerly connected with the general office staff in Philadelphia, Pa.

W. D. Creider has been appointed sales manager of the Oilgear Company, Milwaukee. Mr. Creider was formerly in charge of the Milwaukee, Wis., office of the Federal Machinery Sales Company of Chicago. A. L. Ellis, for the past year acting sales manager of the Oilgear Company, has been appointed eastern representative of the company with headquarters in New York City.

Stanley H. Smith, who was formerly sales agent for the Pennsylvania Steel Company in Chicago and Cleveland and sales agent of the Bethlehem Steel Company in Cleveland has recently opened a shovel warehouse for The Wyoming Shovel Works at 422 Frankfort avenue, Cleveland, Ohio, where he also represents Harrisburg Pipe & Pipe Bending Company, The National Lock Washer Company and The Stevens Metal Products Company.

The Jones & Laughlin Steel Corporation has work under way on an extension of the south power station at its Aliquippa works near Woodlawn, Pa. The construction has been started by Dwight P. Robinson & Co., Inc., New York. The improvement includes preparation of site, foundations and condenser well, and the erection of an extension to the building to house a 10,000 k. w. steam generator unit with condenser and all other appurtenances.

The Independent Equipment Corporation, McCormick building, Chicago, has been incorporated to lease and repair railway cars. M. P. Krafftmiller, formerly vice-president and treasurer of the General American Tank Car Corporation, is president; G. A. Schoemaker, formerly general manager of the Allegheny Steel Company, is vice-president; A. E. Higgins, formerly of the National City Bank, Chicago, is treasurer, and J. E. Bittus is secretary. The corporation will have a plant at Chicago and is now operating one at Warren, Pa.

Scott R. Hayes, vice-president of the New York Air Brake Company, New York City, died on May 6 in the Ossining (N. Y.) hospital while physicians were preparing to operate on him. Mr. Hayes was born on February 8, 1871, at Columbus, Ohio. In 1890 he left Cornell University to go with the Thompson-Houston Company with headquarters at Cincinnati, Ohio. In 1892, when the General Electric Company was formed, Mr. Hayes was placed in charge of its Cleveland office and remained in that position until the latter part of 1894. During 1895 and 1896, he was in the electrical supply business at Cleveland, Ohio, under the firm name of Hayes & Arthur. In 1897, he was appointed agent for the Scott Spring Company with office at Cleveland and one year later he went to Chicago as representative for that company. When the Railway Steel Springs Company was organized in 1902, he was transferred to the New York office as assistant sales agent, subsequently serving as general sales agent and vice-president. He resigned from the latter position in March, 1914, to become assistant to the president of the New York Air Brake Company and subsequently become vice-president of that company. He was a son of former President Rutherford B. Hayes.

Robert H. Gwaltney has been appointed vice-president of the T. H. Symington Company, New York. Mr. Gwaltney was born in Raleigh, North Carolina. He entered the service of the T. H. Symington Company in 1912 as sales agent and remained in that position until 1917, when he was appointed to the position of manager of eastern sales. Mr. Gwaltney now becomes vice-president of the same company with headquarters at New York City in charge of eastern sales, and he will also have supervision of the southern territory formerly handled in Baltimore, Md., by T. C. deRosset, deceased.

R. H. Gwaltney

The Sprague Electric Works of the General Electric Company has consolidated its district and local offices with corresponding offices of the General Electric Company. The manufacture and exploitation of Sprague products will be continued in the name of the General Electric Company in the recently organized merchandise department. The Sprague conduit products section and the Sprague apparatus section of the merchandise department will, for the present, continue offices at 527 West Thirty-fourth street, New York City.

Charles E. Sheldon, for many years connected with the Whitman & Barnes Manufacturing Company, died on May 1, 1923. He was born in Fitchburg, Mass., April 14, 1850, in 1867 became identified with the Whitman & Miles Manufacturing Company, afterwards consolidated with other plants and the name changed to Whitman & Barnes Manufacturing Company. He became superintendent of the Fitchburg works in 1872 and was transferred to the Akron plant in 1877, serving the latter as director, treasurer, general manager, vice-president and president. In 1915 he was elected chairman of the board of directors, which position he held at the time of his death.

Joseph T. Ryerson & Son, Inc., with main plant and offices in Chicago, has bought the plant, stock and good will of the Cincinnati Iron & Steel Company, Cincinnati, Ohio. The Ryerson Company now has steel-service plants in Chicago, St. Louis, Detroit, Buffalo, New York and Cincinnati. The plant of the Cincinnati Iron & Steel Company occupies a full city block at Front & Freemont streets, with about 110,000 ft. of floor space. Lewis E. Skinner, who has been for eighteen years with the Ryerson Company and for a long time in charge of the Ohio business, is now in charge of the plant. He will be assisted by C. A. Parnell, former assistant to Arthur Allshul, manager at the Ryerson Buffalo plant.

The Railroad Supply & Equipment Exchange Corporation has been incorporated in Illinois for the purpose of erecting, in Chicago, a building to be used as the central headquarters for the railway supply trade of the United States. The company expects to erect and operate a building which will be large enough to house permanent and transient exhibits of railway equipment and supplies, office space for supply manufacturers and club rooms. Harry Vissering, president of the Harry Vissering & Co., Chicago, is president; T. G. Kroehler is vice-president and R. W. Lyons is

secretary and treasurer. It is planned to design the building for exhibits that will remain in place for long periods. The first floor will be given over to freight and passenger cars and locomotives. The second floor will hold lighter machinery, tools, signaling devices and other railway supplies. About 14 floors above the exhibition floors will be allotted to offices for supply companies at a rental which it is calculated can be made much less than present rates in many offices. The upper floors of the building will be made into from 300 to 350 rooms with sleeping accommodations; also a swimming pool and a gymnasium. It is also planned to arrange on one of the upper floors an auditorium which may be used by conventions. The district favored for the location of the building is north of the Chicago river and near the Municipal pier. Arrangements have been made for financing the construction of the building and these will be put into effect when tentative leases have been secured.

Oliver W. Loomis, manager of sales of the National Malleable Castings Company, Cleveland, Ohio, has been appointed manager of the company's malleable plants at Chicago with office at 2610 West Twenty-fifth place. Mr. Loomis succeeds O. J. Fehling, who has resigned. James A. Slater, assistant manager of sales, has been appointed manager of sales with headquarters at Cleveland to succeed Mr. Loomis. Oliver W. Loomis was born in Bloomington, Ill., but spent his early boyhood in New Haven, Conn., before going to Cleveland. He has been connected with the National Malleable Castings Company since March, 1891, having served consecutively in the accounting, manufacturing and sales departments. He was manager of sales at the time of his recent appointment as manager of the malleable plants at Chicago.

O. W. Loomis

J. A. Slater

James A. Slater, the new manager of sales, has been in the service of the National Malleable Castings Company continuously for the past 26 years. He served in various capacities both at Cleveland and at Chicago, in the purchasing and the sales departments and in his new position as manager of sales, with headquarters at Cleveland, he will have charge of both the railway and the miscellaneous sales of the various products of the National Malleable Castings Company.

The Uehling Instrument Company, Paterson, N. J., has appointed Charles J. Schmid in charge of sales in Greater New York and Long Island with headquarters at Paterson. Mitsui & Co. have just been appointed exclusive representatives in Japan and China. The head office of Mitsui & Co. is at Tokio and its New York City branch office is at 65 Broadway. John E. Arnold, 15½ South Fourth street, Tulsa, Okla., has been appointed agent in charge of territory in the state of Oklahoma, and H. R. N. Johnson, 917-A Marquette avenue, Minneapolis, Minn., has been appointed agent, whose territory includes Minnesota, North Dakota and South Dakota.

TRADE PUBLICATIONS

TAPS.—The Geometric Tool Company, New Haven, Conn., has just issued a 26-page booklet which is devoted exclusively to illustrations and a description of the construction and operation of its line of adjustable collapsing and solid adjustable taps.

PRECISION TOOLS.—A 15-page booklet, supplementing No. 28 and listing new and useful tools for the machinist, toolmaker and garage mechanic, has recently been issued by the Brown & Sharpe Manufacturing Company, Providence. Among the tools listed are Rex micrometer calipers, micrometer cases, stainless steel rules, gages, etc.

ELECTRIC DRILLS AND REAMERS.—Details of Hisey electric drill and reamer construction and electric drill and reamer motor characteristics are described and illustrated in Bulletin No. 106 which has recently been issued by the Hisey-Wolf Machine Company, Cincinnati, Ohio. The bulletin contains 16 pages and supersedes bulletins Nos. 105-155.

CRANES.—Catalog No. 165, superseding No. 158, has recently been issued by the Whiting Corporation, Harvey, Ill. In this booklet various types of cranes, including electric traveling, bucket-handling, gantry, transfer, handpower cranes, etc., are described and illustrated. Tables of clearances for several types of cranes are also included, as well as a brief outline of the company's facilities for building cranes.

HOISTS AND CRANES.—The Link-Belt Company, Chicago, has recently issued a comprehensive and instructive treatise on electric hoists and overhead cranes. The book is not only profusely illustrated with photographs of actual Link-Belt installations, but with line and wash drawings, the subject of proper installation and efficient operation is fully covered. Practices and methods employed by users in widely divergent fields are also outlined.

SOUTHERN PINE.—The Southern Pine Association, New Orleans, has issued a large-sized, 12-page, illustrated bulletin of technical and general information on Southern pine and its uses. The text deals with the availability, distribution and grading rules for Southern pine lumber; the method of laying and caring for wood block and other types of flooring; and a number of tables of strengths of green and air-dried timber, approximate changes of properties with changes of moisture content, etc.

TUBE CLEANERS.—Air, steam or water-driven tube cleaners for fire tube and water tube boilers, fuel economizers, condensers, evaporators, feed-water heaters, etc., are illustrated and described in a neatly arranged booklet of 32 pages which has recently been issued by the Roto Company, Hartford, Conn. A chart, outlining a practical method of finding the per cent of fuel saved by keeping boiler tubes free from scale, is also included. The booklet is indexed so that information regarding any of the Roto tube cleaning machines can be quickly and easily located.

PORTABLE LOADER.—The Link-Belt Company, Chicago, has issued a 33-page booklet describing and illustrating its line of portable loaders for general and special uses. The bulletin includes descriptions of conveyor loaders equipped with bag filling devices as well as portable machines adapted for use in series with each other and for indoor or outdoor work. Some attention is also given in the bulletin to the Link-Belt crane. Specifications of the machines are furnished, together with a large number of half-tone illustrations showing the machines in various kinds of work.

ARC WELDING AND CUTTING.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has recently issued special publication No. 1659, in which the subject of electric arc welding and cutting is treated in a thorough and interesting manner. The booklet, which contains numerous illustrations, begins with a chapter on the reasons for organizing and standardizing the welding organization, the training of arc welders and the inspection of metallic electrode arc welds. This is followed by chapters on the principles of arc welding, the physical characteristics of arc metal, the use of the graphite electrode, and cost and application data. Several pages are then devoted to a brief description of Westinghouse arc welding apparatus.

EQUIPMENT AND SHOPS

Locomotive Orders

The Lehigh Valley has ordered 10, 4-6-2 type locomotives from the American Locomotive Company.

The Missouri Pacific has ordered 40, 2-8-2 type and 10, 4-6-2 type locomotives, from the American Locomotive Company.

The Seaboard Air Line has ordered 2, 2-8-2 type locomotives from the American Locomotive Company. This is in addition to the 20, 2-8-2 type ordered from the same builder reported in the April *Railway Mechanical Engineer*.

Passenger Car Orders

The Atlantic Coast Line has ordered five dining cars from the Pullman Company.

The Atchison, Topeka & Santa Fe has ordered 25, 70-ft. baggage cars from the Pullman Company.

The Canadian National has ordered 30 steel sleeping cars from the Canadian Car & Foundry Company.

The Seaboard Air Line has ordered four combination baggage and mail cars from the Pressed Steel Car Company.

The National Railways of Mexico have ordered five narrow gage passenger coaches from the Pullman Company.

The Florida East Coast has ordered 15 steel baggage cars, two mail cars and one dining car from the Pullman Company.

The Atlantic Coast Line has ordered 25, 74-ft. steel coaches, 15, 70-ft. steel baggage cars, 5, 70-ft. combination mail and baggage cars, and 2 mail cars from the Standard Steel Car Company.

Passenger Car Repairs

The Missouri Pacific has ordered repairs to 25 passenger cars from the American Car & Foundry Company.

The New York Central has also let a contract to the Merchants Dispatch, Rochester, N. Y., for repairs to 100 baggage cars.

The Missouri Pacific is having repairs made to 50 passenger cars at the shops of the St. Louis Car Company and to 50 cars at the shops of the American Car & Foundry Company.

Freight Car Orders

The Seaboard Air Line has ordered 28 caboose cars from the Magor Car Corporation.

The McMan Oil & Gas Co., Tulsa, Okla, has ordered 15 tank cars from the Standard Tank Car Company.

The Imperial Refining Company, Tulsa, Okla., has ordered 50 tank cars from the Standard Tank Car Company.

The Ford Motor Company has ordered 25 steel gondola cars of 70 tons' capacity from the Standard Steel Car Company.

The Louisiana & Arkansas has ordered 20 ballast cars from the American Car & Foundry Company.

The Atlantic Coast Line has ordered 50 ballast cars of 50 tons' capacity from the Rodger Ballast Car Company.

The Matheson Alkali Works, New York, has ordered from the Standard Steel Car Company 25 special cars for hauling chlorine.

The Chicago & Northern Western has ordered 40, 10,000 gal. capacity tank cars from the American Car & Foundry Company.

The Elgin, Joliet & Eastern has ordered 300 steel underframes from the Ryan Car Company and 200 from J. W. Heggie & Sons, Incorporated.

The Mexican Petroleum Company, New York City, has ordered 50 tank cars of 10,000 gal. capacity and 25 tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

The Southern Carbon Company, Monroe, La., has ordered 25 tank cars from the Standard Tank Car Company.

Freight Car Repairs

The American Refrigerator Transit Company has ordered repairs to 200 refrigerator cars from the Koppel Car Repair Company, Koppel, Pa.

Machinery and Tools

The Chicago Great Western has placed an order for a car wheel borer.

The New York, Ontario & Western has placed an order for a car wheel borer.

The New York Central has placed an order for a journal turning axle lathe.

The St. Louis-San Francisco has placed an order for a 600-ton wheel press.

The Illinois Central has ordered one 150-ton wrecking crane from the Industrial Works.

The Atlantic Coast Line has ordered one 80-ton coach hoist from the Whiting Corporation.

The Central of Georgia has ordered one 150-ton wrecking crane from the Industrial Works.

The Pennsylvania has ordered one 30-ton locomotive crane from the McMyler Interstate Company.

The Chicago & North Western has ordered two electric turntable tractors from the Whiting Corporation.

The Atchison, Topeka & Santa Fe has ordered one 20-ton locomotive crane from the Browning Company.

The Wabash has placed orders for a car journal turning lathe, a car wheel borer, and a locomotive journal turning lathe.

The Chicago, Burlington & Quincy has ordered one, 25-ton electric traveling crane for use at Beardstown, Ill., from the Whiting Corporation.

The Southern Railway has placed orders for a 90-in. driving wheel lathe, a 600-ton wheel press, a 600-pound hammer, and a 100-ton bushing press.

The Southern Pacific has ordered three 25-ton locomotive cranes, one each from the Browning Company, the McMyler Interstate Company and the Industrial Works.

The Denver & Rio Grande Western has ordered four, 120-ton, six, 15-ton and four 10-ton electric traveling cranes and one, 100-ton transfer table for use at its Denver, Colo., and Salt Lake City, Utah, shops from the Whiting Corporation.

The Pennsylvania has recently purchased from the Westinghouse Electric & Manufacturing Company a 20,000 kv-a, turbine generator complete with condensers, auxiliaries, and switching equipment for installation in its Long Island City power house, which supplies power to the Pennsylvania tunnel and terminal electrification at New York. This is the fourth unit of this capacity that the Pennsylvania has purchased from the Westinghouse Company for this power house.

The Erie is installing a motor-driven air compressor at Susquehanna, Pa. Purchased electric power will replace the need for added boiler capacity. At present a steam-driven compressor with a capacity of 2,650 ft. per min. is supplying the requirements of the shop. This will be replaced by a synchronous motor-driven compressor with a capacity of 3,600 cu. ft. The steam unit will be sent to Hornell, N. Y., and a smaller steam-driven unit now in service at Hornell will be installed at Susquehanna as an emergency unit. A 13-panel switchboard is also being installed and underground cables laid between the switchboard and the power lines which bring power to the shops. The switchboard provides for the control of the motor-driven compressor, two motor generator sets, one of which is to be installed, and the various distribution feeders for shop power, light and electric welders. Growing shop requirements have made improved power facilities necessary and 220-volt alternating current, 220-volt direct current and 110-volt direct current is furnished to the shop. The work should be completed by the latter part of July.

Shops and Terminals

ANN ARBOR.—This company will construct a new roundhouse and machine shop at Owosso, Mich.

NEW YORK CENTRAL.—This company will construct an additional car repair shop building at Adrian, Mich.

CHESAPEAKE & OHIO.—This company will add a 100-ft. turntable, a water station and a cinder conveyor to its equipment at Taplin, W. Va.

CHICAGO, BURLINGTON & QUINCY.—This company has awarded a contract to G. A. Johnson & Sons, Chicago, for the construction of a machine shop at Beardstown, Ill.

ILLINOIS CENTRAL.—This company has awarded a contract to the Ellington Miller Company, Chicago, for alterations to a turntable at Memphis, Tenn., which will cost $15,000.

ST. LOUIS-SAN FRANCISCO.—This company has awarded a contract to the Howlett Construction Company, Moline, Ill., for the erection of a 300-ton, reinforced concrete coaling station at East Thomas, Ala.

ST. LOUIS-SAN FRANCISCO.—This company will construct a 15-stall roundhouse and additional shop buildings at Monett, Mo., to cost approximately $500,000 to replace facilities recently destroyed by fire.

THE SOUTHERN PACIFIC.—This company is constructing with its company forces a 16-stall roundhouse, machine shop, power house, car repair shed, mill building, oil house and an employees' building at Lafayette, La.

ATCHISON, TOPEKA & SANTA FE.—This company has authorized the construction of a 1,000-ton reinforced concrete coaling station at Argentine, Kan., and a 600-ton reinforced concrete coaling station at La Junta, Col.

GALVESTON, HARRISBURG & SAN ANTONIO.—This company will construct an eight-stall addition to the roundhouse at El Paso, Tex., and will also erect an addition to the blacksmith shop, a washroom and a fuel oil station.

WASHINGTON TERMINAL.—This company has awarded a contract to the Ogle Construction Company, Chicago, for the construction of a 1,200-ton, five track, reinforced concrete coaling station with sanding facilities at Washington, D. C.

ILLINOIS CENTRAL.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the construction of an enginehouse at Central City, Ky.

The company has also authorized the construction of a 300-ton coaling station at Council Bluffs, Iowa, and a coal hoist with sanding facilities at East St. Louis, Ill., and water treating plants at Parkersburg, Iowa, Iowa Falls, Webster City and Marcus, and at Haldane, Ill., Dixon and Panola.

PERE MARQUETTE.—This company, jointly with the Pennsylvania, has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of a 500-ton reinforced concrete, four-track, automatic electric coaling station at the new engine terminal at Twenty-first street, Detroit, Mich., reported in the March issue of the *Railway Mechanical Engineer* which will be used by both roads.

CHICAGO & NORTH WESTERN.—This company has awarded a contract to G. A. Johnson & Sons, Chicago, for the construction of a roundhouse at Casper, Wyo.

The company also has awarded a contract to the Ogle Construction Company, Chicago, for the construction of a 250-ton, reinforced concrete coaling station at Evansville, Wis., and two 600-ton, reinforced concrete coaling stations at the Chicago shops, Chicago, and has awarded a contract to the C. W. Gimbel Company for the construction of a 30-stall roundhouse, a machine and repair shop, a car foreman's shop and an ice house at Madison, Wis.

MISSOURI PACIFIC.—This company has authorized the construction of a new machine shop at Wichita, Kan., to cost $78,000, and the construction of a viaduct at Fourteenth street, St. Louis, Mo., which will cost $130,000. This company has also authorized the construction of necessary facilities for handling fuel oil for locomotives, including storage at large terminals and outlying supply stations, on the Arkansas, Louisiana and Memphis divisions, which will cost $350,000.

PERSONAL MENTION

General

S. B. ANDREWS has been appointed mechanical engineer of the Chesapeake & Ohio, succeeding J. J. Ewing, assigned to other duties.

J. A. CARMODY has been appointed superintendent of electric equipment of the New York Central, succeeding C. H. Quereau, resigned. A. J. Clarkson has been appointed general inspector succeeding Mr. Carmody.

W. J. TOLLERTON, general mechanical superintendent of the Chicago, Rock Island & Pacific, with headquarters at Chicago, has been given the title of general superintendent of motive power.

J. F. LONG, master mechanic of the Baltimore & Ohio, with headquarters at Connellsville, Pa., has been appointed superintendent of motive power and machinery of the Los Angeles & Salt Lake with headquarters at Los Angeles, Cal., succeeding C. M. Hoffman, who has resigned.

CHARLES F. NEEDHAM, whose appointment as assistant to the general manager of the Canadian National with headquarters at Toronto, was announced in the April issue of the *Railway Mechanical Engineer* was born at London, Ont., on December 9, 1877. He entered railway service in July, 1898, with the Grand Trunk and held the positions of stenographer, head timekeeper, accountant, chief clerk, special assistant to the vice-president in charge of the motive power and car departments, assistant to the general superintendent of the motive power and car departments and as acting assistant to the operating manager. His early experience was in the maintenance of way department. He served for seven years in a divisional motive power department office and fourteen years in the system motive power department office. He then served for a brief period in the operating department and returned again to the motive power department. At the time of his appointment as assistant to the general manager of the Canadian National, Mr. Needham was serving as assistant to the general superintendent of the motive power and car departments of the Grand Trunk.

C. F. Needham

G. DURHAM, superintendent of motive power and cars of the Wheeling & Lake Erie, with headquarters at Cleveland, Ohio, has been appointed acting general manager, with the same headquarters, relieving S. Ennes, president and general manager, and who has given up the duties of general manager on account of ill health.

H. W. RIDGWAY, superintendent of motive power of the Colorado & Southern, with headquarters at Denver, Col., has been appointed assistant to the superintendent of motive power, Lines West, of the Chicago, Burlington & Quincy, with the same headquarters, with jurisdiction over the Denver shops.

F. W. HANKINS, assistant chief of motive power of the Pennsylvania, with headquarters at Philadelphia, Pa., has been appointed general superintendent of motive power of the Central region, with headquarters at Pittsburgh, Pa., succeeding H. H. Maxfield, who has been appointed superintendent of motive power of the Southern division, with headquarters at Wilmington, Del.

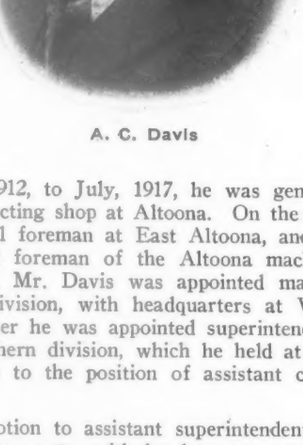
G. B. FRAHEL, superintendent of motive power of the Central Ohio division of the Pennsylvania with headquarters at Columbus,

Ohio, has been given jurisdiction over the Indiana division and will retain present headquarters, the offices of superintendent of motive power of the two divisions having been consolidated. J. E. Mechling, superintendent of motive power of the Indiana division, has been appointed special inspector in the office of the general superintendent of motive power with headquarters at St. Louis, Mo.

Amos C. Davis has been appointed assistant chief of motive power of the Pennsylvania with headquarters at Philadelphia, Pa. Mr. Davis was born on March 20, 1876, at Altoona, Pa. He was educated in public and private schools in Indiana County, Pa. His entire railroad service, dating from April 3, 1893, has been with the Pennsylvania, his first position being that of machinist apprentice at the Altoona shops. At the end of his apprenticeship he was employed as a machinist for about two years and was then made gang leader in the erecting shop. After several minor promotions he was appointed acting assistant master mechanic at Altoona on March 8, 1909, and on April 1, 1910, foreman of the miscellaneous shop. For five years, from July, 1912, to July, 1917, he was general foreman of the locomotive erecting shop at Altoona. On the latter date he was made general foreman at East Altoona, and in October of that year general foreman of the Altoona machine shop. On October 21, 1918, Mr. Davis was appointed master mechanic of the Maryland division, with headquarters at Wilmington, Del. Two years later he was appointed superintendent of motive power of the Southern division, which he held at the time of his recent promotion to the position of assistant chief of motive power.

A. C. Davis

C. K. Woods, whose promotion to assistant superintendent of motive power of the Pere Marquette, with headquarters at Detroit, Mich., was reported in the May issue of the *Railway Mechanical Engineer*, was born on January 14, 1868, at Uxbridge, Canada. He entered railway service in 1885, in the mechanical department of the Erie & Huron, a Canadian line. Mr. Woods was employed as a machinist in the shops of the Toledo Central & Western at Frankfort, Ind., in 1892, and was subsequently promoted to general foreman at the same place. He was appointed master mechanic of the Pere Marquette, with headquarters at Saginaw, Mich., in 1900, and served in this capacity for 18 years. In 1918, at the beginning of federal control, he was appointed supervisor of equipment, but upon the termination of federal operation in 1920, returned to his position as master mechanic at Saginaw. He was serving in this capacity at the time of his recent promotion to assistant superintendent of motive power, with headquarters at Detroit. The position which he now holds is one recently created.



C. K. Woods

S. J. Hungerford, vice-president of the Canadian National, has been appointed vice-president in charge of operation and maintenance of the entire system, into which the Grand Trunk has recently been consolidated. Mr. Hungerford was born on July 16, 1872, near Bedford, Que., and received a high school education. He entered railway service in 1886 as a machinist apprentice on the Canadian Pacific at Farnham, Que. From 1891 to 1897 he served as a machinist at various points in Quebec, Ontario and Vermont. From 1897 to 1900 he was assistant foreman at Farnham, Que. During the latter year he was promoted to locomotive foreman at Megantic, Que. From 1901 to 1903 he served in a similar capacity at Cranbrook, B. C. In 1903 he was appointed master mechanic at Calgary, Alta. In 1907 he was appointed superintendent of locomotive shops at Winnipeg. Seven years later he became superintendent of Western Lines of the Canadian Northern at Winnipeg. A month later he was appointed superintendent of rolling stock of the entire system with headquarters at Toronto. In 1917 he was advanced to general manager of the Eastern Lines with headquarters at Toronto. In 1918 he was appointed assistant vice-president of the Canadian National. In 1920 he was appointed vice-president in charge of operation, which position he now continues with the enlarged Canadian National system.

Master Mechanics and Road Foremen

F. R. Butts, general foreman on the Chicago, Burlington & Quincy, with headquarters at Kansas City, Mo., has been promoted to assistant master mechanic of the Beardstown division, with headquarters at Centralia, Ill.

R. H. Flynn, master mechanic of the Pennsylvania, with headquarters at Indianapolis, Ind., has been transferred to Columbus, Ohio, succeeding T. B. Farrington. W. R. Davis, assistant master mechanic, with headquarters at Wilmington, Del., has been promoted to master mechanic, with headquarters at Indianapolis, Ind., succeeding Mr. Flynn.

O. E. Ward, assistant master mechanic of the Galesburg division of the Chicago, Burlington & Quincy, with headquarters at Galesburg, Ill., has been promoted to master mechanic of the Alliance division, with headquarters at Alliance, Neb. H. H. Urbach, general foreman, with headquarters at Denver, Colo., has been promoted to assistant master mechanic of the Galesburg division, with headquarters at Galesburg, Ill., succeeding Mr. Ward.

Shop and Enginehouse

T. B. Farrington, master mechanic of the Pennsylvania, with headquarters at Columbus, Ohio, has been appointed assistant works manager of the Altoona shops at Altoona, Pa.

W. J. Hill has been appointed supervisor of work equipment of the Atchison, Topeka & Santa Fe, Eastern lines, with headquarters at Topeka, Kan., succeeding C. A. Braillier, who has been assigned to other duties.

Car Department

George Edward Smart, whose appointment as chief of car equipment of the Canadian National with headquarters at Montreal was announced in the April issue of the *Railway Mechanical Engineer*, was born in Edinburgh, Scotland, and entered railway service in August, 1892, in the car department of the Grand Trunk. He held various positions in this department and in 1904 was appointed general inspector of heating and lighting on the Canadian Pacific. In 1906 he was promoted to general car inspector and three years later to divisional car foreman of the Eastern lines of the Canadian Pacific Railway. In October, 1913, he was appointed master car builder of the Canadian Government Railways and five years later he was appointed superintendent of the car department. In 1919 he was appointed general master car builder of the Canadian National and in 1920 to mechanical assistant to the vice-president, which latter position he held until the time of his recent promotion.

Purchasing and Stores

A. V. B. Gilbert has been appointed purchasing agent of the Atlanta, Birmingham & Atlantic with headquarters at Atlanta, Ga., succeeding A. D. Daniel, promoted.

C. N. Davids, who served for 35 years as purchasing agent of the Colorado Midland and later as purchasing agent of the Denver & Salt Lake, died on May 3 at Alamosa, Col.